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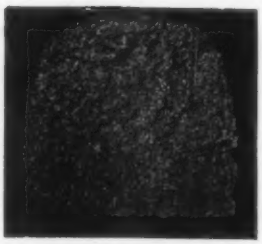
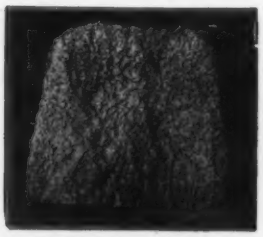

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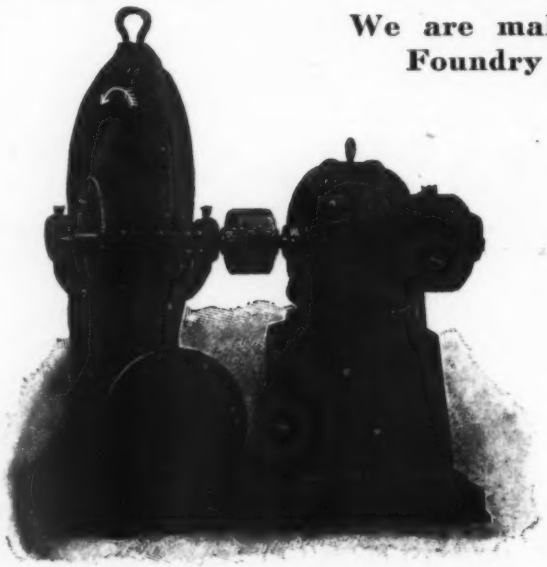

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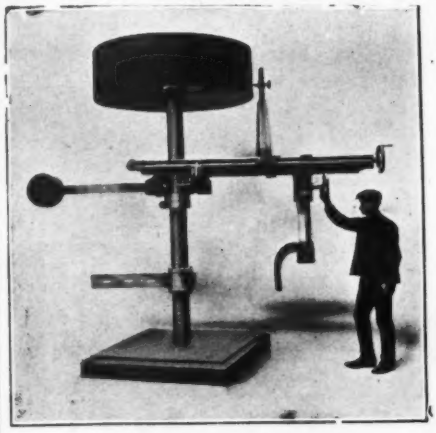

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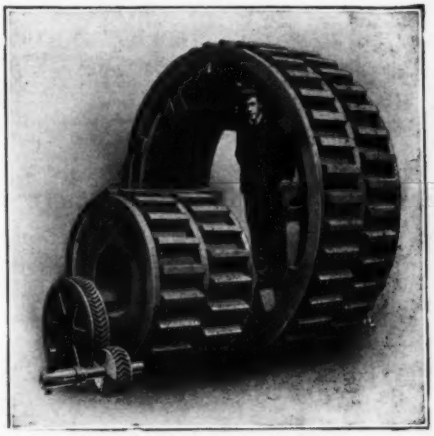

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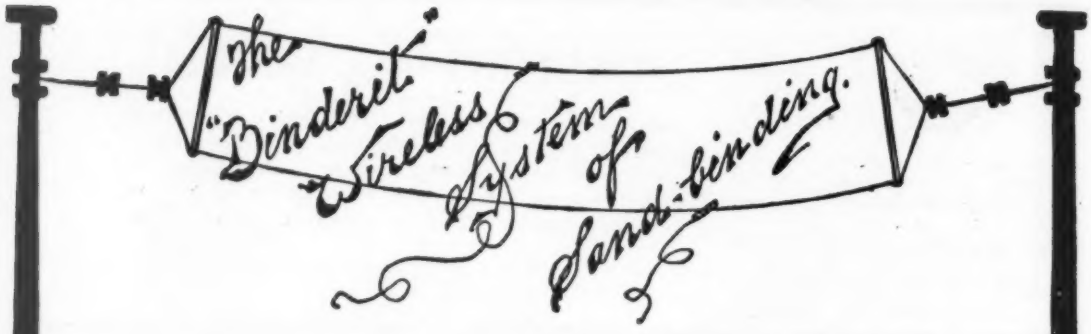

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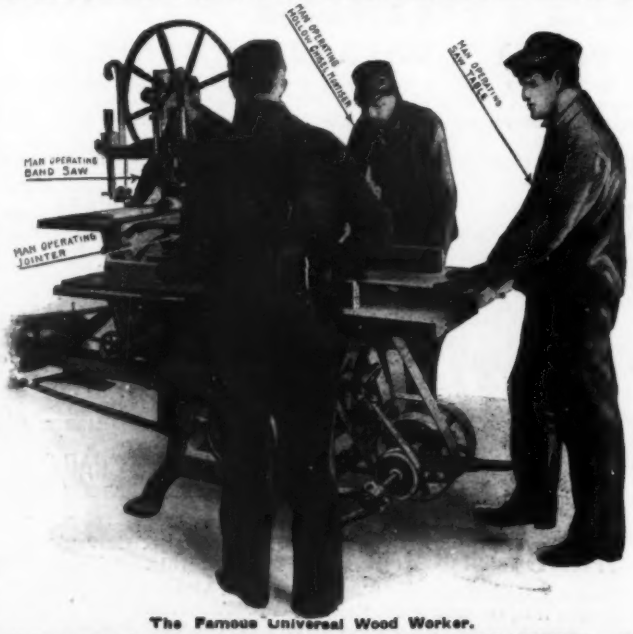

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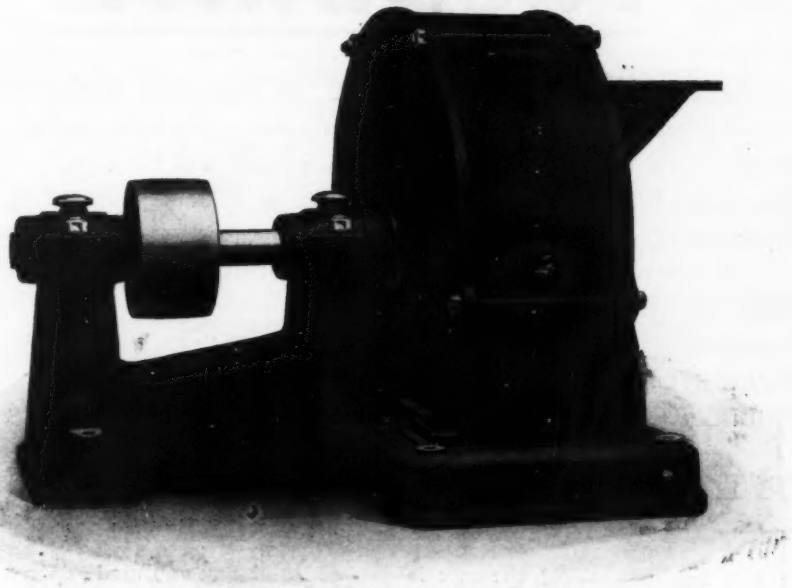

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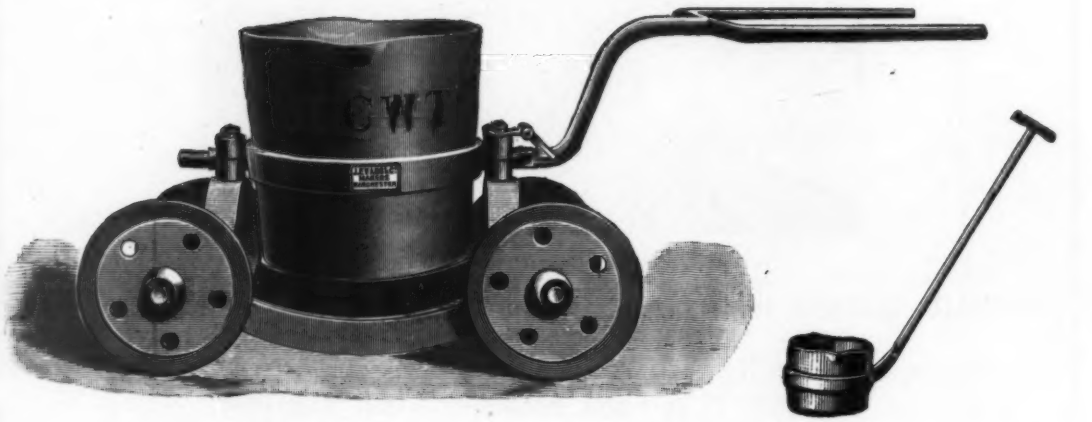

EVERYTHING FOR THE FOUNDRY.

The Foundry Trade Journal

AND PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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NOTES AND COMMENTS.

Organising Industry.

The work of the Munitions Office is perhaps in too early a stage to allow a proper consideration of the national effort to organise our industries for the requirements of a successful war; but so far the results of the activities of the new Ministry of Munitions appear to be quite on the right lines. In the work as recently organised, one important change was the placing of the supply of raw materials in a special department, under the direction of Mr. Leonard Llewellyn. It is obviously a matter of first importance to control raw materials and their prices, and very necessary attention has been paid to the prices of metals required for munition manufacture. Perhaps, partly by reason of good luck, but certainly by good management, the whole aspect of the supply of raw material and the price at which that supply could be secured has been altered. One of the first acts of the new Munitions Ministry was to fix prices. Shell steel, for instance, which had been sold at differences of price of 100 per cent., was fixed at a level which should afford a satisfactory margin of profit to the steel maker. Similarly, the prices of the alloys used in the Sheffield trade have been brought under control. The decline in the chief war metals, such as copper, spelter, and pig-lead, has been remarkable. The price of spelter has been falling steadily; the decline since the beginning of August has been £21 (from £98 to £77). The depreciation from the topmost point seen this year is equal to over 50 per cent., and while prices are still abnormal relief is already being felt by consumers. Copper prices have dropped in the past month to the extent of about £4 a ton. We do not suggest, of course, that these differences are all due to the new raw materials branch of the Munitions Department. The factors affecting the price of metals are various, but the fact that the dominant buyer in the market, that is, the British Government, has taken steps to organise the business on business lines and to fix prices, has no doubt had a very material influence.

In the provision of manufacturing plant the supply of presses, machine tools, etc., has been met by practically nationalising the whole of the machine-tool trade and the industries associated with it under the control of Mr. Alfred Herbert. As regards gauges, which have delayed so often the operations of many contractors, the problem has been placed on a much more satisfactory footing, and a special office was appointed some weeks ago to deal with the question, which has had the assistance of Dr. Glazebrook, of the National Physical Laboratory.

The mapping of the country into various areas within which local munitions committees should organise output has on the whole worked out well. There are 11 of such areas, with 33 local munitions committees, some of the districts having as many as nine committees. The country has yet to reap the full benefit of this new organisation in manufacturing, and it can hardly be expected that steps involving practically the nationalisation of the more important part of several of the staple trades of the country could be taken without some expression of dissatisfaction and some genuine grievances; but the broad result is undoubtedly beyond question.

German Organisation.

Turning to the organisation of the enemy's resources for war, we learn from a Rhenish-Westphalian newspaper that the foundry associations of the country have been active in assisting the manufacturers turning out war material. The Verein Deutscher Eisengiessereien undertook the work of technically and economically advising the members in contracts for projectiles in so far as grey cast shells were concerned, whilst the same duties were performed in the case of cast steel shells by the formation of a special union of steel foundries and a department of the small Bessemer plants in the iron foundries Association. The object of these arrangements was to promote as far as possible the delivery of shells to the Army authorities and to assure the obtaining of appropriate but not excessive prices. Hitherto practically nothing has been said publicly respecting these arrangements, but they are an example of how German industry organised immediately for the execution of Army requirements as from the beginning of the war. The report of the above-mentioned Association for the year 1914-15, which was submitted to a recent meeting, pointed out that the apprehension of great general unemployment which was entertained at the outset had been proved baseless, but on the contrary a great scarcity of skilled workers had arisen, which had been filled by the introduction of female labour to an extent which had not been thought of, and by the adoption by the Army and Civil authorities of measures for the maintenance of suitable wages. The Army requirements were overwhelming. The transformation which was effected for this purpose was a triumph of the German capacity for organisation. About 50 new small Bessemer plants had been brought into existence.

There is no doubt that military and industrial organisation for war was in the early stages of the conflict far more advanced in Germany than here, from which, by the now customary process of German reasoning, we may deduce her pacific intentions. It is incidentally interesting to note that this report appears to confirm the statement that Germany is using a proportion of cast-iron shells. There is a feeling in many quarters that our output might be increased by adopting similar material, but we understand that there is no shortage of the steel shell cases now used, as they can be obtained more readily than the fittings can be prepared. There are, also, technical objections to cast-iron shells, though we think they would probably prove more apparent than real in the event of a shortage of steel cases.

Bessemer Converters for Large Steel Castings.

It is generally recognised that for small or relatively small castings, the Bessemer converter, or one of its modifications, is a useful and economical unit, particularly where the output is not regular. As an auxiliary to an iron foundry, also, the converter has an established place. At the same time, it is not unusual to make occasional large castings in steel foundries having small converters, by uniting several heats, the first blown heats being held in the ladle under a covering of slag until the required weight is reached. A whole series of heats can be successfully united if a mixer or collector of proper construction is used that is well preheated. This method is in operation at the Fonderia Milanesia di Acciaio at Milan, Italy. In 1894 several castings up to 6 tons in weight were made, a mixer being used, and since then the weight has been increased to 25 tons, a larger mixer having been built. Experience has shown that the quality of the steel is greatly improved by its long holding. Purification takes place similar to that noticed in the case of pig-iron mixers. Recently castings of 30 tons have been made, weighing 45 tons with the casting heads. More steel than this must be made, due to a possible skulling in the mixers during the long wait. The steel-making capacity consists of three 1-ton converters, two open-hearth furnaces of 3 to 4 tons, one open-hearth furnace of 6 tons (at the most 8 tons), and a Stassano electric furnace holding about 1 ton. Only one converter can be blown at a time, owing to insufficient blast, so that as fast as one is turned down another is turned up. Also only two open-hearths can be run together. There are two mixers, one holding 15 and the other 20 tons. The converters were blown for four hours, and in that time made 40 tons; one open-hearth furnace 8 tons, another 5 tons, and the electric furnace 1 ton, altogether 53 tons. This large excess of 8 tons was to counterbalance skulls in the mixers, which amounted to 6 tons. The steel, nevertheless, cast all right. The experience gained with this first large casting was used several weeks later when a second was made; 34 tons of steel was blown and 4 and 7 tons respectively were obtained from two open-hearth furnaces. No skull was left in the mixers. The cupola charge for the converters consisted of 50 per cent. hematite with very high silicon and 50 per cent. steel scrap of 0.2 per cent. Si.

Possibilities of Waste-Heat Utilisation.

In a recent article in the "Iron Age," Mr. G. Butz draws attention to the great waste of heat which occurs in the Bessemer process for making steel. He expresses his belief that this heat can be utilised in somewhat the same manner as in the blast furnace, puddling furnace, and open-hearth furnace, and to a greater degree of efficiency. There is, of course, no question that the heat escaping from the nose of the converter during the blow is of enormous value; but just what the value is has no doubt been a matter of conjecture. The author submits calculations which, he says, apply to one particular heat of steel, but the analysis of the hot metal charged shows it to be a fair sample of the general run of Bessemer pig-iron. A reasonable difference in the results of the calculations on any heat of steel, however, would not affect the purpose, which is merely one of investigation. The author makes the following assumptions:—(1) That the theoretical amount of oxygen needed is the actual amount used; (2) that all of the iron (Fe) lost is oxidised to slag in the form of FeO; (3) that the air enters the tuyeres at 0 deg. C., and no account is taken of its atmospheric condition. Any or all of these assumptions throw the final result lower than it really would be under actual conditions. The author concludes that the total heat available is the sum of the sensible heats of the gases, and the heat of the combustion of CO gas, and is equal to 4,690,938.4 kg.-cals. in the instance which he cites. Hence the thermo-mechanical equivalent of the total heat =7,434 h.p.-hours, or 5,546 kw.-hours. If 1 kw.-hour is worth 2½d., then this energy transformed would be worth £55 10s. The weight of the heat of steel was about 12 tons. So that per ton of ingots the value would be £55 10s. ÷ 12 = £4 12s. 6d. Therefore, if all the heat carried out of the nose of the converter by the escaping gases from one charge could be transformed into electrical energy and sold at 2½d. per kw.-hour, steel ingots would immediately become a by-product of an electric power plant. But that is theory. In practice, attaining a thermo-mechanical efficiency of about 10 per cent. would be enough upon which to congratulate ourselves.

Manufacture of Cast-Iron Tunnel Linings.

By Louis J. Josten.*

The accompanying illustrations relate to the manufacture of cast-iron tunnel rings for the New York subway system, now being made at the works of the Wheeling Mold and Foundry Company of Wheeling, W. Va., U.S.A. Nine segments and a key are required to make a complete ring which, when assembled, is seventeen feet six inches in diameter.

The patterns, core-boxes and core-prints used are all of metal, thereby ensuring uniform accuracy. The manufacture of the castings is done mostly under one roof—a building 575 ft. long and 60 ft. wide—equipped with three overhead travelling cranes and two travelling wall cranes. The building is laid out with foundry, core-room, cleaning and chipping room, machine shop, inspection and despatching departments. Starting at one end of the building, the casting is put through its various operations until it reaches the other end a finished article. The moulds and cores are made by machines, which produce castings more true to the pattern, as rapping of the pattern is necessary to loosen the pattern from the mould before drawing hand-rammed moulds, and this is sometimes done very carelessly by the moulder, thereby enlarging the mould considerably and giving increased sections in various parts of the casting which are not needed. Machine moulding does away with this danger of careless rapping by the use of a vibrator.

A source of trouble with hand-rammed moulds is blow-holes caused by poor venting of the moulds rammed by hand. This uncertainty is avoided by machine-made moulds, as one can depend entirely upon the porosity of the moulding sands for the escape of gases. The use of swabs on machine-made moulds is also eliminated. Swabs are used on hand-rammed moulds to moisten the edges of the sand around the pattern before drawing it from the mould. The foundry swab is a dangerous tool.

Moulds made upon machines can easily be held within four per cent. of the required weight, while my records on past tunnel contracts show a variation of ten per cent. in the weights of the castings poured from moulds rammed by hand. With machine-moulded castings, therefore, the thickness for machining is more uniform, due to uniform ramming of the moulds and absence of rapping of the pattern before drawing.

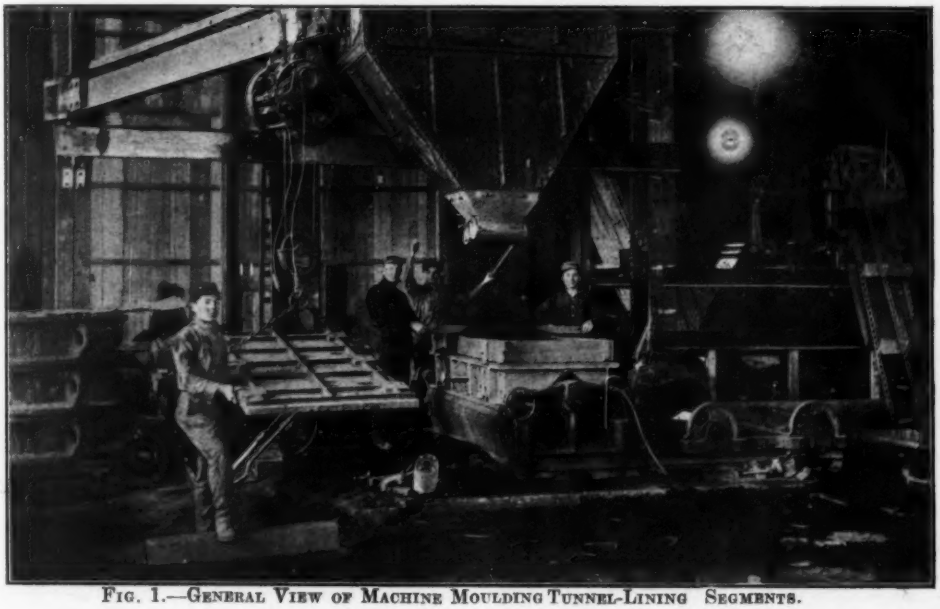


FIG. 1.—GENERAL VIEW OF MACHINE MOULDING TUNNEL-LINING SEGMENTS.

Fig. 1 shows an Osborn direct-draw roll-over jolt machine, also part of the sand-mixing conveyor and a crane for handling the bottom plates. To the extreme right is shown part of the sand-mixing conveyor. The old and the new sands in the proportion of one part to ten parts are shovelled into a hopper built below the ground level, from which the sand is conveyed by means of chain buckets to another hopper built about six feet above the ground level. From this hopper the sand enters the screen, and falls through to another hopper built below the ground level which contains two spiral screws. These screws cut the sand and at the same time bring it forward to the elevating buckets which convey it to the large hopper. Directly under this hopper is the Osborn moulding machine upon which the drag moulds are made. The ramming, the rolling over of the flask and the drawing of the pattern are all done by compressed air. The flask is securely pinned to the roll-over table and a wooden hopper placed above

* Copyright by the Author.

as a sand guide. After the flask and hopper are filled with sand, the machine is then ready to be jolted, 80 blows of the machine being required to ram

FIG. 2.—ROLLING FLASK OVER READY FOR DRAWING PATTERN.

correctly. The wooden hopper above the flask is then removed, after which the men run a stick lengthwise across the flask to level the sand. This is

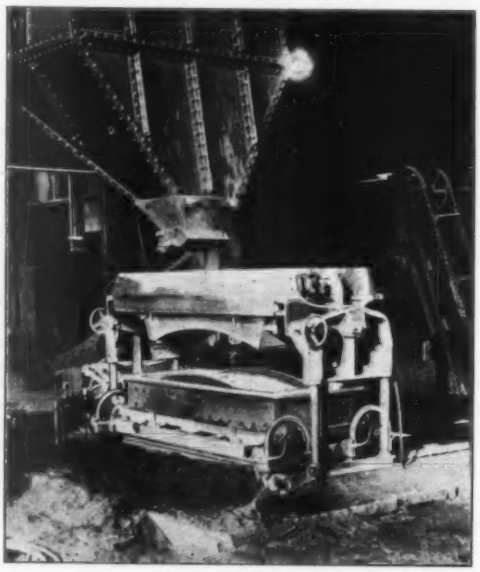


FIG. 3.—PATTERN DRAWN AND MOULD LOWERED ON TO TROLLEY.

then followed up by putting on the bottom plate, which is securely fastened. The flask is then rolled over as shown in Fig. 2 until the grooves of the roll-over table insert themselves upon the shafts of the hand wheels located on each side of the machine, which are afterwards tightened to hold the flask and table in position. After this the mould-receiving car is pushed under the table, the roll-over table to which the flask is fastened is lowered upon the mould-receiving car, and any unevenness of the bottom board is taken up by wooden wedges.

The pins which hold the flask to the roll-over table are loosened, the pattern being drawn from the mould as shown in Fig. 3. While raising the roll-over table the vibrators, one on each side of the roll-over table, are operated. The mould now rests upon the small car, which provides easy means for withdrawing from under the roll-over table. This brings the mould entirely clear of the machine, from where it may be removed to the pouring floor.

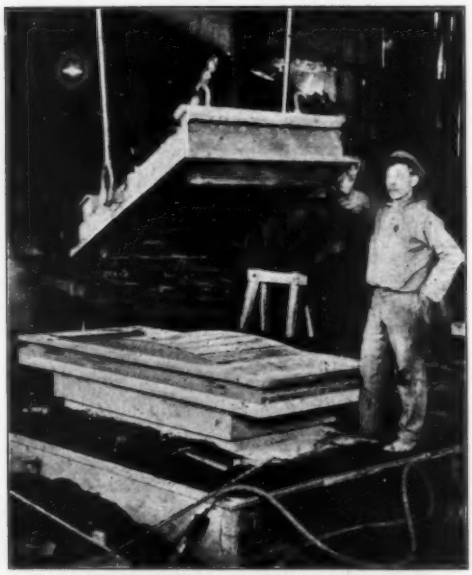


FIG. 4.—JOLT MACHINE MAKING TOP PARTS.

Fig. 4 shows a plain jolt machine upon which are made the cope moulds. (The drag and cope moulds for the key can also be made upon the machine.) The moulds are rammed by power the same as the drags, but there is no rolling-over of a flask or drawing of a pattern to contend with. After the mould is rammed the moulder builds the runner box.

Fig. 5 shows a drag mould as it came from the machine. It will be seen that at each end of the mould there is a large opening to accommodate the end core. The five end holes and bosses, including half of the end side core-prints, are all made in one core. The end cores are at present made by hand, but will eventually be made upon a small roll-over machine with a direct pattern draw, upon which are made the side cores. Eight side cores are made upon this machine (Fig. 6) at one time, the boxes being of metal and of one piece. They are drafted about 1-32 in. Splitting of the core-box was objected to on account of leaving a fin on the forty-five degree chamber. These core boxes were made by machining up a master core-print and machining out the core-box $\frac{1}{4}$ in. larger than the core-print. The master coreprint was then taken and placed within the core-box and Babbitt metal poured around, thereby insuring that the shapes of the core and the core-

print coincided. Fig. 7 shows a rack of side cores ready to go to the oven to be baked, which usually takes from four and a half to five hours.

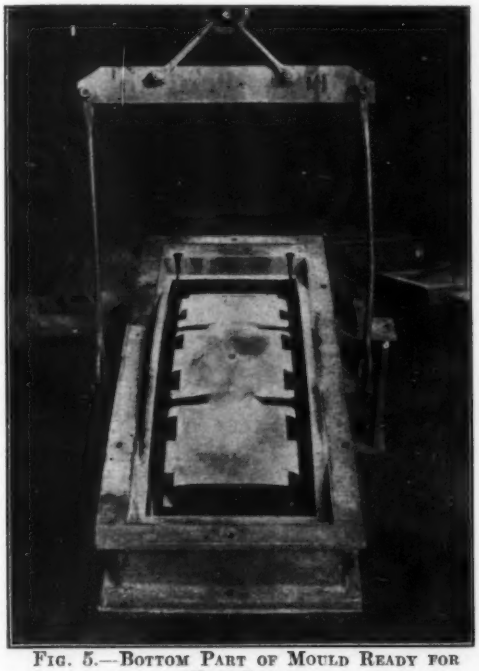


FIG. 5.—BOTTOM PART OF MOULD READY FOR END CORES

The iron used is a good quality number two grey pig-iron, cupola melted. No mill-cinder iron, white or burnt iron of any kind, nor old fire-bar scrap is

FIG. 6.—MACHINE MAKING SIDE CORES.

used. Test samples are cast, and a set of two test bars is required for every twenty tons of castings poured. In case of a change of mixture during the heat, one set of two bars is cast for every mixture other than the regular one. The quality of the iron going into the castings is determined by means of the "arbitration bar," 1¼ in. in diameter and 15 in. long, which must show a traverse strength of not less than 3,000 lbs., and a deflection of not less than 0.10 in. Borings are taken from the broken bars for chemical analysis.

After the castings are sufficiently cooled, the flasks are shaken out and sand-blasted, and while the temperature of the casting is still above three hundred degrees Fahr., it is dipped in a vat containing tar, the tarring acting as a protective coating. After being dipped, the castings are placed upon skids and allowed to drain off. They are then sent to the chipping department to have the fins, risers, and gates chipped off.

Machining of the sides and ends, including the drilling and tapping of the grout hole, is the next operation. The sides and holes are all drifted and then submitted for final inspection. After having passed inspection the castings are stamped, the machine surfaces are coated with white lead and

FIG. 7.—RACK OF SIDE CORES READY FOR STOVING.

tallow so as to prevent rusting, the weights are taken, and they are then dispatched for service.

THE following announcement is made by the Board of Trade:—Professional men who have practical experience in various branches and grades of the engineering trades and are anxious at the present time to place their services at the disposal of the Government are invited to consider the possibility of undertaking manual work in connection with the production of munitions of war. The great need of the moment is for skilled mechanics (turners, fitters, millwrights, etc.). Men whose training has included engineering workshop experience can now do valuable service by offering to do manual work at the usual rates of payment for such work. They will not displace any skilled workman who is already employed or is capable of being employed upon the production of munitions. They will simply increase the army of those who by work at home help the Armies abroad. Professional men who wish to offer their services to this end should send full particulars of their qualifications to the "Engineers' War Service Register," Queen Anne's Chambers, Westminster, S.W.

Heroult Furnaces for the Foundry.*

Electric furnaces of small size may be used to take the place of crucible furnaces. A furnace of this kind at the Lebanon Steel Foundry, Lebanon, Pennsylvania, U.S.A., is of one-ton capacity, with a maximum demand of 250 kilowatts, and is supplied with 3-phase, 60-cycle, alternating current at 2,300 volts, which is stepped down to 100 volts across the line, giving approximately 45 volts at the arc. The power factor is 97, and an interesting feature is that the furnace load has brought up to 90 the power factor of the plant, which includes motors for a sand-mixing machine, air compressor, grinders, etc. The tilting is controlled so easily that it is possible to pour the entire heat into hand ladles without losing any of the metal. The automatic regulation enables the current to be left on until practically all of the metal has been poured from the furnace. The fluidity of the metal is such that it has been an easy matter to pour without difficulty the small castings usually produced by the crucible foundry.

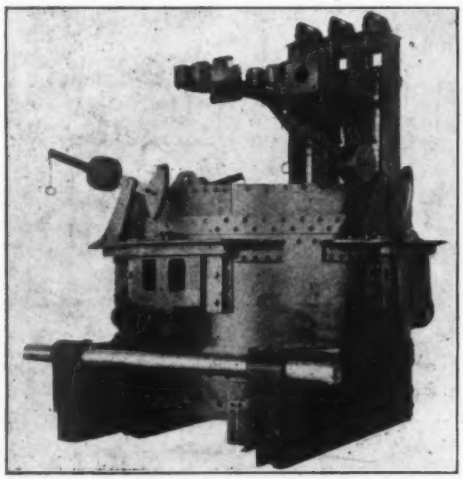


FIG. 1.—SHELL OF ELECTRIC FURNACE, 3-TON TYPE.

Heats of electric steel are being made with two slags in from three and a-half to four hours. The two slags are being used for dephosphorising, desulphurising, deoxidising, and killing the metal, and faster time could be made by melting down with one slag, but the aim in view is to produce steel equal to crucible steel. Some of the advantages claimed for the electric furnace in the foundry are the long periods between the heats, during which time the men may keep consistently at their work, avoiding interruptions for pouring as in crucible practice. The demand for low-carbon steel in small castings can be more readily met as the result of the use of all of the scrap.

The accompanying illustrations show the features of the furnace. A shaft, Fig. 1, runs across the front of the furnace, immediately below the spout, and rests in pillow blocks, with the result that the spout is practically stationary during pouring. The counterweight box is filled with pig-iron and is supported on levers which are attached to the furnace by connecting rods. A worm gear, driven by an electric motor, equipped with a magnetic brake, operates the tilting machinery. The magnetic brake makes it possible to stop the furnace at any point, even though the friction of the worm gear is insufficient. The tilting mechanism is so adjusted that it is possible to tilt it by hand. A feature of this design is that the connection between the main driving gear and the furnace is similar to a locomotive connecting rod, so that in lifting or lowering the furnace the motor may be operated in either direction, and should the operator allow the mechanism to run past the high or low point, no damage results, and no automatic brakes or checks are required. If left to itself, with the current on, the mechanism would continue its reciprocating motion.

The distance of the electrodes above the bath is approximately 1 in. The resistance in the air gap between electrode and bath is increased or decreased by raising or lowering the electrode a small

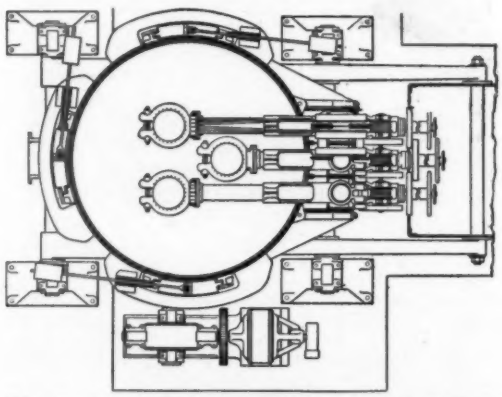


FIG. 2.—PLAN OF FURNACE SHOWN IN FIGS. 3 AND 4.

fraction of the total gap; this is done automatically. On the Lebanon furnace, the Thury automatic regulator is used, the special feature of which is that the impulses given to the motors which lift and lower the electrodes are intermittent. A solenoid in series with the main line leading to the furnace, causes the regulator to make contacts which throw direct current into one or the other side of the operating motors. Thus the furnace is operated in accordance with its requirements for quantity of current, not voltage. Each impulse given by the regulator lowers or raises the electrode something less than $\frac{1}{8}$ in. By resistances in parallel with the solenoid on the regulator, the regulator can be made to give the furnace any predetermined quantity of current. Although to bring the load up to a certain point a number of impulses may be required, there is a check between each movement. Consequently if a boil occurs in the furnace, or the sudden movement of a piece of scrap causes a sudden reversal of conditions, the regulation is extremely accurate, as the electrode is not floating between high and low points.

In conjunction with the regulators, there are three controllers, by means of which any one or all of the electrodes may be thrown on to the automatic regulation, or may be stopped from all movement. By means of the controllers the regulators may be cut

* Abstract from "The Iron Trade Review."

out and a rapid upward or downward movement of the electrodes obtained. In addition to the possibility of operating with the regulators, or direct with the motors through the controllers, clutches are provided at the back of the furnace which cut out the motors, and the electrodes may be operated manually by means of hand wheels.

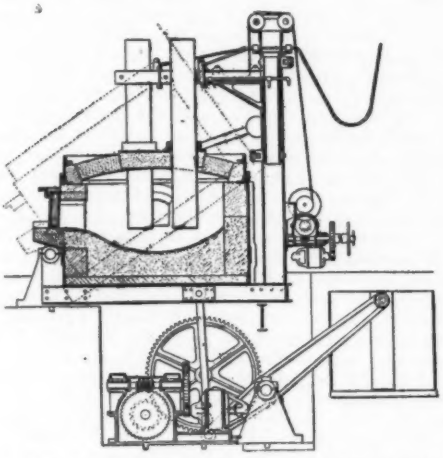


FIG. 3.—ELEVATION OF HEROULT FURNACE FOR FOUNDRY SERVICE.

To maintain the short arc in the furnace, automatic regulation is obtained in the same way as in an ordinary arc lamp. The transformer room, which is of brick, is located at the rear of the furnace, and the cables are lead in overhead.

The superstructure for supporting the electrodes gives added strength to the furnace, and is so spaced as to allow for proper radiation from the shell. The

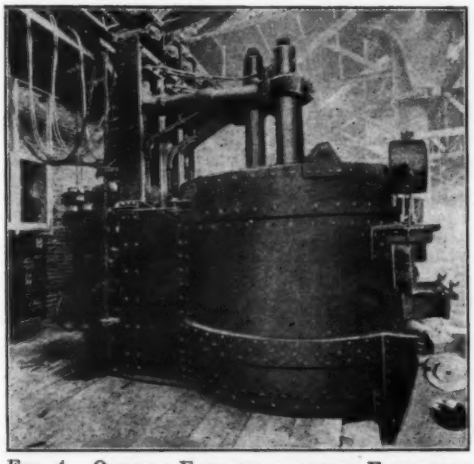


FIG. 4.—ONE-TON FURNACE, SHOWING ELECTRODES AND OPERATING MECHANISM.

cranes for supporting the electrode holders are adjustable in all directions, giving a desirable flexibility. The electrode holders are opened and closed by means of a right-and-left screw to provide for the easy slipping of electrodes. These, as well as the electrode coolers on the roof of the furnace, are water cooled. The roof, as usual, is built in a removable ring.

The electrodes, three in number, are of amorphous carbon, 8 in. in diameter, and threaded to provide for continuous feeding. The three electrodes are for the three phases of the current.

While it is considered desirable to increase the power input and hasten the melting time to reduce the radiation losses, this operation has to be carefully conducted. The refining operation is a function of time only, and it is desirable from the power standpoint to keep the maximum demand at a reasonably low point. It is necessary to maintain a low voltage so that the short arc can be retained, and it is also of importance not to increase the cost of transformers, copper cables, bus-bars and electrodes beyond a reasonable point. It is thought by engineers that there is a mean between these points which will give the greatest efficiency, and it appears that 250 kilowatts on a one-ton furnace of this type about fulfils the requirements.

The tendency of electrodes is to become pointed, due to the oxidation, and for this reason a large electrode is desirable, and the arc playing about its surface is held to the bath with what has been called the "umbrella" effect. It has been found possible to obtain a life of from 200 to 250 heats for a roof 9 in. thick in melting cold scrap and 125 to 150 heats in refining molten scrap.

The design for the one-ton furnace is followed in the two- and three-ton sizes. This is merely a matter of making the bath larger and of strengthening all parts for the heavier weights to be handled.

THE PLASTICITY OF CLAY AND ITS RELATION TO MODE OF ORIGIN.—In the course of a Paper on this subject read by Mr. N. B. Davis, at the New York meeting of the American Institute of Mining Engineers, the following points are emphasised:—(1) Clean crystalline rock powders do not develop plasticity on the addition of water, no matter how fine they may be ground in the dry form. (2) Such powders if ground in water for a long time do develop some plasticity. (3) Those powders containing minerals least easily attacked by water, such as quartz and feldspar, develop least plasticity. (4) Water exerts a solvent action on the mineral grains, resulting in colloid and true solution, the colloid modifications remaining as coagulated sols, gelatinous coatings over the mineral grains. (5) Organic gel bodies in small amounts increase the viscosity of the water films in mineral powders. The effect seems to be more pronounced than that of equal amounts of the inorganic gels, as shown by Grout's experiments with agar and with gelatinous alumina. (6) The amount of gel matter present in a clay depends on the past history of the deposit. Clays are simply the weathering products of crystalline rocks in which the most soluble constituents have been removed, leaving behind more resistant secondary products (crystalline and amorphous) with gelatinous coatings. (7) The most highly plastic clays are those that have been subjected to the action of water for long periods. Residual kaolins are of low plasticity, but water-transported kaolins of exactly the same chemical composition are quite plastic. Plasticity in clays, then, concludes the author, is due to the gelatinous state of matter, a state common to them because of their mode of origin. This gelatinous matter may be silicic acid gel, alumina gel, iron oxide gels, silicate gels, or organic gels. Two or more of these are usually present, and their effect will be further modified by absorbed salts and the relative proportions of large and small grains, and to a limited extent by the shape of the grains. The particular kind and amount of gelatinous matter present, the size and shape of grain, and the relative proportions of large and small grains, are important factors in determining the other related physical properties of tensile strength and air shrinkage.

Gun-Metal Founding.

The following notes, while not exhaustive, attempt to summarise the important features which distinguish the casting of gun-metal from that of various other brasses and bronzes. The compositions which come under the heading of gun-metal include chiefly the following:—

Copper.	Tin.	Zinc.
88	10	2
88	11	1
87	8	5
87.5	6.25	6.25
84	12	4

There are, of course, some variations on the above, which, however, are standard alloys. The first is the recognised Admiralty steam metal, the second for other Admiralty work, the third for propellers and various other work, the fourth is a mixture suitable for bolts and similar work, as it has a tensile strength of 14¼ tons with an elongation of about 23 per cent. on 10 in. when cast in dry sand. The final mixture is well-known as a marine-bearing mixture. An alloy of 86.5 Cu., 13 Sn., and 0.5 per cent. P. is sometimes classed as a gun-metal, but is really a phosphor-bronze.

Admiralty Specification.—The 88:10:2 mixture is required by the Admiralty specification to have not less than 10 tons tensile strength and not less than 7½ per cent. elongation on a 2-in. test piece, but the breaking strain with first-class work may go up to 16 tons and the elongation is not infrequently 14 per cent.

Mixing.—In making gun-metal the copper should be melted first at a fairly rapid rate in a good fire, a cover of broken glass or powdered charcoal being used to protect from the atmosphere or the furnace fumes. When the metal is molten the tin should be added, and finally, the zinc, just prior to pouring, the temperature then being raised slightly to overcome the chilling effects of the addition. A small piece of phosphor-copper as a deoxidiser adds fluidity and aids soundness.

Quality of Metal.—The great essential in meeting Admiralty specifications is purity of raw materials. The copper must essentially be of first-class quality, with arsenic not more than about 0.25 per cent., preferably less. Where arsenic is present in excess in the metal great difficulty is experienced in meeting the tensile-strength requirements. For this reason scrap copper from fire-box stays, etc., should not be used. The lead content of the tin should be kept low, not more than 0.25 per cent. in the metal being a fair rule, as the lead content is inclined to increase with the remelting of the scrap and the Admiralty specification stipulates 0.5 per cent. in the mixture as the maximum.

Melting.—The protection of the metal during melting by means of glass or charcoal is very important, since the oxide of copper formed by contact with the atmosphere is readily absorbed by the molten copper itself and is difficult to separate. The presence of 2 per cent. of zinc, however, acts with a deoxidising effect, though it is far safer to avoid the presence of the oxide than to attempt its elimination, particularly since the zinc content is materially reduced if it has to act as a deoxidiser and pass off in the skimming

Overheating of the metal in the furnace must be avoided, as the hotter the metal is kept the greater is the liability to absorb gases into the molten metal. The moulds should always be made to wait for the metal, and not the metal for the moulds. The pots should not be uncovered and the metal exposed unnecessarily during melting, for the nearer melting under complete protection is attained the better for the metal.

Temperature of Pouring.—As a maximum temperature to which the metal should be raised 1,300 deg. C. may be set. This allows a reduction to about 1,200 deg. C., or rather less, for the temperature of pouring into the moulds, and the metal should not go much below 1,100 deg. As a practical rule, it should not be allowed to become at all pasty during pouring, for in that condition it is too cold to give a sound casting, and both tensile strength and elongation will be below the requirements.

Position of Pouring.—For certain classes of work vertical pouring gives the soundest results, since the casting is more or less self-feeding, cooling proceeding from the bottom upwards, and the deeper molten metal serving more or less as a head. This position, however, in other classes, is liable to cause serious draws and shrinkages, and also may result in a porous top portion, where dissolved gases are present in objectionable quantities. Also, with vertical pouring there is a danger of liquation of tin, which is apt to separate out, giving irregular composition in the casting. For this reason horizontal pouring is frequently found most satisfactory. The rate of pouring should be much more rapid than with iron; in fact, the metal should be poured as rapidly and fully as possible.

Flushing the Mould.—With gun-metal, which is a somewhat sluggish metal, it is found well to flush the mould by pouring extra metal through to clear away any gases which are liable to be entrapped. This practice, however, is not necessary where phosphorus is added, as that element considerably increases the fluidity.

Moulding.—The moulds for gun-metal may be either green-sand or dry-sand. Much small work can be cast in green-sand, but if difficulty is experienced with blow-holes it is advisable to dry the moulds, and this is frequently done in larger work, as the trouble may be due to gases created in the moulding blowing through the metal to escape. These gases are, of course, practically removed during the drying process, and there is only the contained air in the mould to be attended to. An open-grained sand usually obviates this trouble. Holes from dissolved gases being liberated are only dealt with by more careful melting or by changing the copper, and in most cases where holes other than blow-holes from the mould itself are experienced the difficulty may be traced to impurities in the copper.

Gating.—In order to allow rapid pouring the gates should be ample, much larger than for iron, though excessively large gates are both unnecessary and bad, since they allow undue contact with the air, owing to the difficulty of keeping them full. For light work the gates should be arranged so that the flow of metal does not cut against cores more than necessary, and has as far as possible an unimpeded passage to every part of the mould. Parts to be machined should be wherever possible cast down, as the oxide which is inevitably present to some extent floats when it separates out by combining with the zinc. For heavy work the mould should be gated so as to feed the part last to solidify, and if this is not possible a riser should be put on the heavy part. Broadly speaking, the casting is denser when no riser is used, but only a good head, though the

slight difference is not sufficient to rule out the use of risers on heavy parts.

Round gates are usually cleaner than square ones. Sprays should not taper out towards the mould, but be smaller at the mould end than at the runner feeding them, as this allows them to send a steady stream in without undue churning, and the chilling of the metal in the mould is not so liable to cause drawn places near the spray. In intricate work the gate should often be led round to pour at more than one point so as to fill all the mould before the metal chills too much. This also is often necessary in order to avoid a heavy flow cutting the weak internal parts.

Venting.—Owing to rapidity of pouring and the consequent necessity of clearing the air and gases in front of the molten metal instead of blowing them through it, the moulds must be well vented.

Sand.—The sand for gun-metal castings does not require to be so strong or refractory as for iron, but should be drier and rammed harder. An open texture is essential to aid the venting, the usual brass-foundry sand being quite in order for gun-metal work.

Plunging Heavy Castings into Water when still hot from the mould is common practice, but care should be taken with irregular designs or this will result in unduly rapid shrinkage of various parts causing cracking.

Steel and Malleable Cast Iron for Motor-Car Work.

Discussing the subject of "Automobile Manufacture and the War," before the Institution of Automobile Engineers, Mr. L. H. Pomeroy said that in considering the difficulties with which the motor-car manufacturer is faced now that Continental supplies cannot be obtained, it is well to remember that this country has an enviable reputation for producing high-quality goods of all kinds. We have created a goodwill far too valuable to be thrown away by the emulation of any "get-rich-quick" methods which are not based upon the intrinsic and lasting qualities of the article supplied. This point involves a condition which has to be recognised by suppliers of the parts to be discussed later, namely, the impossibility of anything like large outputs of any particular parts, and of cost reduction by extreme sub-division of labour.

It is well known that there are in this country few firms, if any, who produce a motor vehicle completely and entirely from raw material. Quite 50 per cent. of the material composing a motor car is supplied wholly or partly finished by firms who specialise in the various lines of manufacture concerned. A large part of the trade in these commodities has been in the hands of Germany and foreign trade rivals. After all, the basis of production is an ample supply of raw material and an ample choice of the sources of such supply. The elimination of Continental sources of supply has brought home to many of us how dependent we were upon them, and further, how poorly some of our British suppliers compare with those on the Continent. The comparison is still more unfavourable to the British supplier when considered in the light of quality for price.

In saying this the author anticipates criticism and repudiation of his statement, so that he will say at once that it is possible to purchase supplies in this country with a few exceptions equal to anything produced in the world, but only from limited sources. It is this limitation to which he draws attention.

After discussing to some length the question of heat-treated steels and steel stampings, Mr. Pomeroy concluded:—When the field for the supply of malleable-iron and steel castings is surveyed we become painfully aware of our deficiencies. The modern steel casting is an electric-furnace product. It is to-day a matter of difficulty to obtain steel castings suitable for motor-car work in this country, regardless altogether of price. In particular, steel road wheels are practically unobtainable. The production of a cast wheel in any metal is a matter of difficulty, owing to the contraction stresses induced by unequal cooling, and the difficulty is probably greater in casting soft steel than in any other metal.

The author has tried to get castings of exhaust manifolds $\frac{1}{4}$ in. in thickness and failed. He then put the thickness up to $\frac{5}{16}$ in., and got sound castings; but, unfortunately, upon sawing them up he found the thickness to vary from $\frac{5}{16}$ in. to $\frac{7}{16}$ in., mostly the latter. The importance of the subject is more far-reaching than is at first imagined, and the expenditure of a lot of time and money on the production of very thin castings, say down to $\frac{3}{32}$in thick, would be well rewarded.

The external finish of steel castings is also another weak spot. This may not sound important, but it is one of the things that, other things being equal, decide the destination of contracts. Malleable iron certainly scores in this respect. When dealing with steel and malleable castings from the same pattern the two metals are quite easily identified. The chief complaints in regard to malleable castings are occasional hard batches and perpetual delay in delivery. It is necessary to be a prophet to deal with malleable iron successfully. Its physical characteristics are, however, very good. There seems no reason why it should not be a good material for road wheels and compete with steel castings all round.

FLUORSPAR PRODUCTION AND USE.—Fluorspar has of late years found considerable application in the iron and steel industries, particularly in America. The bulk of the fluorspar sold in the United States is used in the steel industry. Gravel spar is consumed as a flux in basic open-hearth steel furnaces, and to a smaller extent in other metallurgical operations. Large quantities of gravel spar produced at a low cost from the tailings of lead mines and from the gob in abandoned mines in England have been shipped to America as ballast at a very low freight rate. The material thus produced is high in silica, and is almost entirely consumed by makers of open-hearth steel. According to American producers, spar from England at present competes with American fluorspar as far west as Pittsburgh, and other localities near the Atlantic seaboard. English fluorspar can be purchased advantageously. Since 1903 the output of fluorspar in Great Britain has exceeded 10,000 tons annually, and except in 1898, 1911, and 1912 there has been a steadily increasing annual production of spar up to 1913, the latest year for which statistics are available. According to the official report of output of mines and quarries issued by the Home Office, there were produced in 1912 a total of 47,246 tons of fluorspar, valued at £16,800, and 53,663 tons, valued at £14,550 in 1913. In 1912, 23,862 tons were produced in Derbyshire, mostly from quarries and open workings (probably mine dumps), and 23,384 tons from mines and mine dumps in Durham. Of the 1913 output, 11,433 tons were produced from mines in Derbyshire, probably including large quantities produced from mine dumps, and 19,830 tons from quarries in the same county, while 22,400 tons were produced from mines and mine dumps in Durham. It appears that more than 37 per cent. of the production of England was shipped to the United States in 1913.

Altering Old Patterns.

By William J. Horner.

In considering the most economical way to produce any casting, the patternmaker has nearly always to decide whether an old pattern can be altered instead of making a new one. In very plain and small articles the question may arise as to whether it is worth searching for a suitable pattern with the possibility of not finding one. A bush, for instance, might be turned in ten or fifteen minutes and the material in it would be of little value. On the other hand, there are large patterns of unusual shape never likely to be wanted again and occupying a great deal of room in storage. Even if alterations

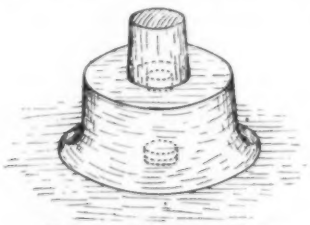


FIG. 1.—CIRCULAR PARTS KEPT IN PLACE BY CENTRAL STUDS.

to these cost almost as much as a new pattern, it is generally good policy to use them. In some instances of this kind, when the pattern is very plain, there may be so much material and so little work in them that they may with advantage be taken apart as soon as done with and the material used for other work.

Alterations to a pattern may mean adding or cutting off portions, or cutting off may be avoided by "stopping off." The possibility of the original being wanted again generally has to be borne in mind, and the alterations are usually carried out in such a way that restoration will be easy. From this point of view the cutting away of any portion of the original

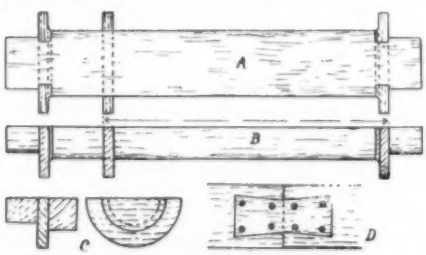


FIG. 2.—*A* AND *B*, HALF OF A PIPE PATTERN TO BE SHORTENED BY STOPPING OFF; *C*, STOPPING-OFF PIECE; *D*, METHOD OF LENGTHENING.

is objectionable. If a part can be unscrewed and taken away bodily and kept for replacement, there is not much risk of trouble or mistake, but if the wood has to be sawn and chiselled, replacement of the parts cut away is impossible except by remaking them and devising suitable means for their attachment.

Some patterns are constructed with a view to facilitating future alterations. A common example of this is the attachment of prints and bosses and other circular parts by central studs, as in Fig. 1. Such parts frequently have to be altered in size, and this can be done quickly and accurately by taking off those parts of the size not wanted and substituting others. In many cases a moderately tight-fitting stud or pin is all that is necessary for holding the parts together, and the moulder finds this convenient if he wants to take them off for mending the mould. A boss coming in the bottom of the mould is usually screwed as well as fitted with a central stud to the pattern, but top bosses are generally left unscrewed. Prints are held by their studs only. A turned article, such as a wheel of any kind, which has central bosses, has its central stud hole bored in the lathe, and studs on the loose bosses are turned to fit it. In a few cases such bosses may be solid with the wheel, but as a rule they are separate for convenience

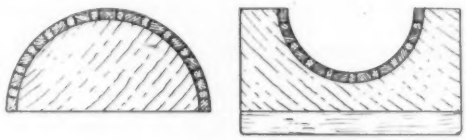


FIG. 3.—CURVED SURFACES THICKENED UP BY NAILING ON LONGITUDINAL STRIPS.

in changing and for removal by the moulder if he wants them for mending up. The latter reason doesn't apply if the bosses are shallow with large fillets or a large amount of taper. Important centres for the attachment of circular parts may occur anywhere on a pattern which is not circular, as in brackets or other castings bored for carrying shafts. In such a case a stud hole may be bored with a centre-bit.

Stopping off instead of cutting off a portion of the pattern is a very common practice when only one or only a few castings are required for the modified pattern. An example of this is shown in Fig. 2, where *A* and *B* represent two views of half a pipe pattern. The length over the flanges being greater than required, a third flange is fitted round the body of the pipe at the length wanted. The patternmaker has also to make a stopping-off piece for the moulder's use. A side and end view of the stopping-off piece required in this case are shown at *C*. It has a half flange, with a half print on one side and a

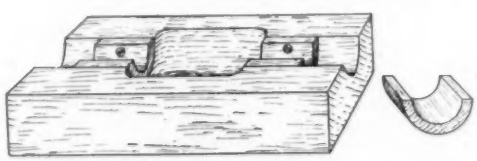


FIG. 4.—CURVED PIECES CUT FROM SOLID.

short portion of the half pipe body on the other, the latter not being really essential.

This principle can be applied to all cases where portions of a pattern are to be stopped off. In many cases there is no core, and therefore no print on the stopping-off piece, the latter being simply a suitably-shaped piece of wood for ramming sand against in filling the portion of the mould which is not wanted. The preparation of the pattern also may be simpler than the example described, and often consists only

in scribing a line across to indicate where the casting ends.

Added thickness on flat surfaces only requires wood planed to correct thickness and nailed on. Curved surfaces are more troublesome, and in such cases materials more pliable than wood are often employed. These materials may be anything with a surface smooth enough for moulding from. The amounts to be added are often very slight, and it is chiefly for thicknesses under 3-16 in. or ¼ in. that wood is troublesome to use. Thick paper, sometimes several layers of it, may be stuck with shellac or glued to a curved surface. Leather, sheet lead, and various kinds of cloth with smooth surface, bradded or tacked on the wood, provide quick though rough means of thickening up curved parts of small patterns, one or two castings from which may be wanted in a hurry. But when the thickness to be put on is considerable, and especially if the surface is large, wood is usually employed, sometimes in conjunction with plaster-of-Paris or other filling. Wood is nearly always put on in strips, as shown in Fig. 3. In the best work the strips would be fitted close together and then planed to the curve, but usually they are simply planed to thickness and left flat, with spaces between as shown. In large work these spaces are filled with loam by the moulder; in most small work the patternmaker would make the surface uniform by filling with plaster of Paris or other stopping. This method of fitting is practised because there are so few instances where wood can be bent to follow a curve properly. An alternative is shown in Fig. 4, where a block of wood is cut to fit

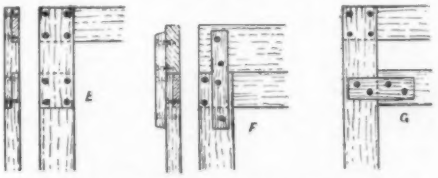


FIG. 5.—*E*, SIZE OF FRAME INCREASED BY INSERTING A PIECE; *F*, PIECE HELD TO THE EDGE BY BATTEN; *G*, PIECE INSERTED FOR REDUCING SIZE.

the curve. This takes more time, but the added pieces can be removed and replaced quickly without breaking if held by screws. Pieces can only be fitted in this way when their proportions happen to be suitable. They must be small and moderately thick. The example in Fig. 4 is a half-core box with two pieces fitted into it.

Rectangular plates for various purposes, with or without flanges, are usually framed up with half-lap joints, as in Fig. 5. Very often they are not filled in solid, but consist merely of a skeleton frame in the pattern, the enclosed sand being strickled away by the moulder. In any case, it is often necessary to reduce or increase the length or width of such plates but leave the original pattern fit for use again. Increased size is obtained by additions; reduced size by stopping off. If the amount to be added is considerable, the original joints are unscrewed and new pieces fitted in as at E. Smaller amounts are attached to the edge by battens as at F, or, if only an inch or so has to be put on, it could be nailed without the battens. The impressions left by the latter, of course, are filled up by the moulder, so that they do not appear in the casting. The stopping off of a considerable amount would be done by fitting a new piece at the required distance as at G, and providing the moulder with a short stopping-off piece for making the corners good. If the pattern is a solid plate, or if the stopping-off line occurs on the wood where a new piece cannot be inserted, then a line is scribed across and the moulder is provided with a stopping-off piece the full length or width of the plate.

Thermal Conductivity of Refractory Bricks.

A Paper read before the American Electro-Chemical Society by PROFESSOR BOYD DUDLEY, JUN., of the Pennsylvania State College, deals with "The methods and results of an investigation designed to develop a practical and reasonably accurate means of determining the thermal conductivity of regular kinds of brick, under conditions approaching those of practice and without the necessity of preparing special shapes or samples of the materials being tested." The author first gives a classification and review of the various methods which have been devised to measure the heat conductivity of refractories and then describes his own method, which was applied to tests of four types of brick, *i.e.*, first-quality fireclay brick, silica brick with clay bond, silica brick with lime bond, and magnesite brick. Details of the composition of the different bricks are given in Table I:—

TABLE I.—*Analysis of Brick.*

	Woodland. Per cent.	Quartzite. Per cent.	Star silica. Per cent.	Magnesite Per cent.
SiO_2	52.93	73.91	95.85	2.50
Al_2O_3	42.69	22.87	0.88	0.50
Fe_2O_3	1.98	1.48	0.79	7.00
CaO	0.33	0.29	1.80	2.75
MgO	0.38	0.31	0.14	86.50
Alkalies	1.55	1.20	0.39	—
Loss on ignition ..	—	—	—	0.10
Apparent density ..	1.91	1.91	1.56	2.46

The results of the measurements of heat conductivities are given in deg. C. in Table II.:—

TABLE II.—*Heat Conductivities of Brick.*

Material.	Test No.	Exp. temp. range.	Mean k over exp. range.	Calc. k at 100°.	Calc. k at 1,000°.
Woodland ..	1	120 to 965	0.00676	0.00532	0.00816
Woodland ..	2	100 to 1025	0.00666	0.00438	0.00880
Woodland ..	3	400 to 995	0.00704	0.00332	0.00886
Quartzite ..	1	100 to 935	0.00679	0.00504	0.00880
Quartzite ..	2	100 to 960	0.00670	0.00521	0.00836
Star silica ..	1	100 to 910	0.00794	0.00561	0.0108
Magnesite ..	1	445 to 830	0.0343	—	0.0343

The third column gives the temperature range in deg. C. for each test. The fourth column gives the mean conductivity k for this temperature range in gramme-calories per second per inch cube per deg. C. Columns 5 and 6 give calculated values of the heat conductivities k at 100 deg. and 1,000 deg. C. respectively.

While the calculated conductivities are in some cases not in close agreement, in general they are consistent in indicating the relative conductivities of the various materials. Taking the averages of the figures applying to each material, the conductivities at 100 deg. and 1,000 deg. C. are given in Table III. in gramme-calories per second per inch cube per deg. C.:—

TABLE III.

Material.	Average k at 100 deg.	Average k at 1,000 deg.
Woodland	0.0043	0.0086
Quartzite	0.0051	0.0086
Star silica	0.0056	0.0108

For magnesite brick it was found that between 445 deg. and 830 deg. C. the conductivity of the magnesite brick was practically constant, the value being 0.0343 gramme-calories per second per inch cube per deg. C. For this reason magnesite brick is not included in the above Table III. It is estimated that the precision of the figures representing mean conductivities is within 5 per cent.

Metal Spray Processes.

By John Calder.

One of the great metallurgical problems of the day has been to produce a non-corrosive surface on iron and steel, the indispensable but vulnerable materials of engineering construction, without affecting the physical properties of these metals or the shape or usefulness of the object treated. This has been attempted by chemical, electro-chemical, and mechanical methods. Tinning, galvanising and sherardising are the ordinary wet and dry chemical methods of applying a protective metal coating directly to a considerable volume of engineered and manufactured product, but these processes are narrowly limited in the variety of their applications.

Plating– the electro-chemical method—furnishes a continuous thin metallic web around iron or steel objects submitted to it, provided the shape and size of the article are suitable. It is necessarily limited to small objects. The adhesion of the plated coating is slight and its continuity is essential for service. The tinned or galvanised coating adheres, due to chemical affinity for clean iron, but its irregularity gives much trouble. The dry zinc galvanising, known as sherardising, gives a better result but is limited to the application of one metal under heat conditions, which confines it largely to black work and to objects the distortion of which is of no consequence.

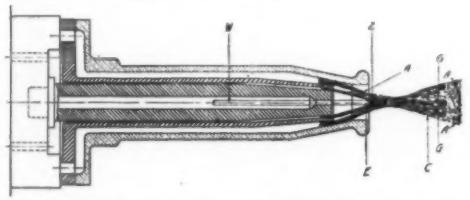


FIG. 1.—DIAGRAM ILLUSTRATING APPLICATION OF REDUCING FLAME TO METAL WIRE IN THE PISTOL.

None of the processes which have been briefly mentioned meet the general needs of the arts in a satisfactory way. The permanence of the resulting adhesion is not assured and many of the coatings rapidly deteriorate. There are demands in the arts for a method which will take the process to the work to be coated or to any part of it, and will secure the quick deposition on any coherent object, whether metallic or not, of any desired metal or alloy in any quantity, however minute. Effective pulverisation of the very hardest metals still presents economic difficulties, but lead, tin, zinc, aluminium, copper, nickel and their alloys can now be sprayed easily, and these metals cover very well the practical range of protective coatings.

The latest mechanical process—the Schoop process—for depositing electro-positive metals on iron and steel is now well known. The evolution of the apparatus has been interesting The liquid-metal process involved a large non-portable reservoir of hot metal weighing with the auxiliary parts over a ton; the metal-dust apparatus weighed over 100 lbs., while the "pistol" of to-day weighs less than 4 lbs. The obvious objections to the liquid-metal process were lack of portability and the expense of melting and keeping fluid most of the metals in the unavoidable intervals of spraying. The result was that only the more fusible metals, lead and tin, were used where spraying on a continuous scale was possible and the liquid metal apparatus was never reduced to economical practice. It was observed with this apparatus, however, that the particles were not actually molten at the moment of impact and this suggested the next step.

In the second form of apparatus, using dust, portability was secured and the metal particles to be sprayed were prepared in advance. Powdered metals in a very fine state of division have many of the characteristics of a liquid. Their fine particles mix with one another like drops, they spread with facility and unite under the influence of very little force. Most metal powders, however, tend to oxidise rapidly and the use of this apparatus was practically restricted to tin and zinc on this account. Even with tin, the expense of metallic powder was prohibitive, but the plating with tin and zinc was very good. In the case of zinc the apparatus known as the Cyclone is still the most economical instrument for plating large surfaces with that particular protective metal. Zinc dust is a by-product in the stacks of zinc smelteries, With the Cyclone apparatus, it can be impacted on steel structures either in the field or at the factory.

Inventors then set themselves to overcome both the chemical and economic difficulties, viz., to dispense

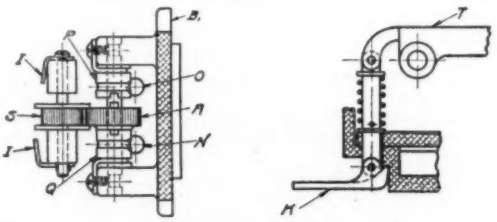


FIG. 2A.—DETAILS OF THE COMMERCIAL METAL-SPRAYING PISTOL NOW IN USE.

with mass melting and dust preparation and to secure instant and simultaneous operation of melting and pulverisation, and control with a handy, economical and easily transportable appliance. The result was the ingenious instrument known as the "pistol."

The principle involved consists, as shown in Fig. 1, in feeding a fine wire W of any metal into a reducing flame zone Z at such a constant speed that the position of the end of the wire E remains stationary, the melting rate being exactly equal to the rate of feed. Under such conditions the wire end melts a drop at a time and each drop at the instant of formation is struck a violent blow by an air blast A. In other words, the pistol is a machine gun which automatically manufactures its ammunition from a reel of wire and bombards the object to be plated with plastic projectiles of extremely small size. The resulting fog or spray of fine metallic particles into which the drops are divided takes the form of a diverging cone C with a core of reducing gas G in which the particles are entrained, and a surrounding sheath of air A which is rapidly expanding and cooling. Any suitably prepared object placed in the path of this metallic spray is plated through impact without undue elevation of temperature.

Figs. 2 and 2A show details of the commercial spraying pistol now in use. The principal parts of the pistol consist of an outer casing A_1,

* From a Paper read before the New York local section of The American Society of Mechanical Engineers.

cast of aluminium, with a central projecting tube forming a handle; a wire feed mechanism mounted entirely upon the cover B_1 of the turbine chamber; the turbine C_1 actuating the wire feed mechanism; gas, air and wire nozzles mounted upon the outer casing held in position by a hand nut D_1, and a removable cover E_1, which completes the enclosure of the outer casing. Gas and air ducts are drilled in the outer casing. The flow is controlled by the tapered valve F provided with a handle G. The wire feed mechanism is actuated by a turbine C_1 mounted on a vertical shaft running in ball bearings; a worm is cut in the upper end of the vertical shaft and drives by worm wheels the horizontal shafts N and O, which are provided with worms in turn driving the worm wheels P and Q. The wheels P and Q are provided with slots to engage the projecting lugs of the lower feed wheel R. The upper feed wheel S mounted in the pivoted frame T is provided with shrouds controlling the position of the lower feed wheel R. The lower feed wheel can be engaged in either worm P or Q by raising a clip I, shifting laterally in either direction and locked in by the opposite clip. The shift can be readily made by allowing the mechanism to run slowly by a slight opening of the starting valve. Pressure is applied to the feed wheels through the pivoted frame T by a coiled spring, and controlled by the operator by means of the release lever K. The final adjustment of the wire feed is controlled by the needle valve M. The turbine and shaft complete is assembled in the outer case and properly adjusted independently of the other mechanism.

The wire feed is entirely assembled on the turbine cover and, when properly adjusted, is secured in position. The wire nozzle base U provides an adjustment for position of wire and gas nozzles, and is secured in position by a headless set screw. The upper end of the stem of the turbine cover is provided with an annular groove, which is engaged by the spring loop V and secures the removable cover E of the case. Loop V provides also a means for hanging the pistol on a conveniently located hook.

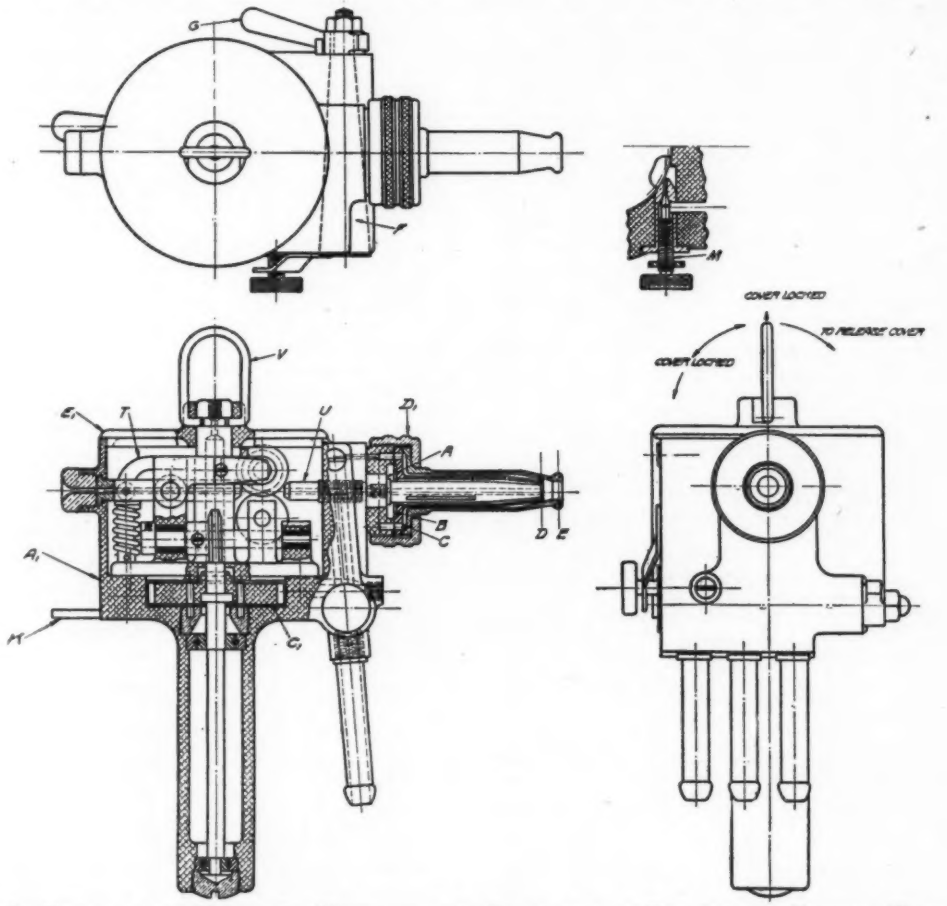


FIG. 2.—DETAILS OF THE COMMERCIAL METAL-SPRAYING PISTOL NOW IN USE, SHOWING TURBINE, WIRE-FEED MECHANISM, ETC.

The operation of the pistol is as follows:—The gas and blast nozzle faces B and C are securely clamped to form gas-tight joints by tightening the hand nut D. The end of the central or wire nozzle is then 0.015 in. inside the gas nozzle, and the stationary melting point of the wire is 0.03 in. inside the air-blast nozzle. The wire diameter used is from 0.0319 to 0.0375 in., except for lead and tin, which are used in larger sizes owing to their rapidity of melting.

The feed gears having been set in mesh at the approximate speed required for the wire selected, the air alone is turned on and the speed tested with a short length of wire. Adjustment, if necessary, is made by the needle valve, which modifies the speed 2 ft. per min., plus or minus.

The end of the wire rod is then threaded through the stock receiving tube, between the gripping feed rolls and into the central wire nozzle and the fuel gas pressures from the containers are adjusted by the reducing valves and gauges thereon to the tabular requirements for the metal to be sprayed. The pressures of the fuel gases seldom rise above one atmosphere, and hydrogen or Blau gas are the reducing gases usually employed. This gas is now admitted by slightly opening the starting valve, and when ignited burns quietly as a pilot light.

The starting valve is then opened up full and oxygen is admitted gradually until the flame zone is established. All back-firing is avoided by keeping the reducing gas always in excess of the oxygen, the ratio being three or four to one. The above movements are made in rapid succession on a light instrument which can be held in one hand and the spray is started up the moment the constant melting position of the wire is reached.

The spray so established is essentially a metal plating air-brush, the diameter of which 5 in. from the pistol end is about 2 in. Objects to be plated are operated upon by pointing the pistol normally to the surface to be coated at any moment at about 5 in. distance and traversing the pistol across the surface with a regular motion. A single coating is about 0.001 in. thick. The operator's vision easily guides him in distinguishing between the coated and uncoated portions and also between a first and second coat.

Two-thousandths of an inch well impacted upon a surface are just as effective as a much greater thickness, and of course unnecessary sprayed metal increases the cost, as the latter is directly proportional to the thickness. Not only on the score of economy but also to preserve toughness the coating should be of minimum thickness, for the anvil action of the metallic spray on a solid metal object is lost above a few thousandths of an inch thickness, and a process of cold working follows which produces a brittle scale readily detachable. In practice this matter is easily regulated.

It will be seen from Table II. that 0.001 in. thickness, one sq. ft. in area, can be sprayed with the common metals for a small sum. The total cost for nickel silver is 1.72d., for copper 1.43d., for tin 4.8d., for brass 1.35d., for zinc 0.98d., for aluminium 0.85d., and for lead 1.37d. per sq. ft.

TABLE I.—*Details of the Cost of Using Metal Spraying Pistol One Hour.*

Metal.	Diameter, inches.	Speed of wire in feet per minute	Pounds per hour.	Oxygen.			Blau Gas.			Cost of spraying.	Wire cost per hour.	Total cost per hour.
				Gauge pressure.	Cubic feet.	Cost at 1d. cub. ft.	Gauge pressure.	Cubic feet.	Cost at 0.4d. cub. ft.			
						s. d.			d.	s. d.	s. d.	s. d.
Copper	0.032	12	2.15	27	24	2 0	25	13	5½	4 6	1 6½	6 0½
Brass	0.032	12	2.15	28	21	1 9	26	14	5½	4 3½	1 4½	5 8½
Bronze	0.032	12	2.15	27	24	2 0	25	14.5	5½	4 6½	1 9½	6 4
German silver	0.032	12	2.15	28	23	1 11	26	14	5½	4 6	2 3½	6 9½
Aluminum	0.0375	16	12.00	19	36	3 0	16	13	5½	1 4	1 10	3 2
Zinc	0.0375	18	4.30	15	20	1 8	13.5	10	4	4 1	5 2	9 3
Lead	0.076	25	30.00	14	20	1 8	12	8	3½	4 0	12 6	16 6
Tin	0.061	25	15.00	13	24	2 0	14	10	4	4 5	43 9	48 2

Various theories have been offered to account for the plating properties of the metal spray, but it is believed by those putting it to practical use that, except in the few cases where the impacted metals have a chemical affinity, the action of the spray is purely mechanical.

Any metal wire can be sprayed with varying degrees of fineness by the pistol, but a hard metal, such as copper, cannot be impacted with the same degree of adherence upon a solid copper object as it would be upon a more porous cast-iron object or upon one of the soft metals such as lead or zinc. The coatings may be ground, polished and buffed like any ordinary metals, but polished sprayings do not offer themselves as economical substitutes for cheaper and less adherent platings which are deposited in smooth condition.

As metal spraying is essentially a kinetic energy process, the degree of adherence obtained in any instance depends upon the relative hardness and porosity of the sprayed metal and its base. In spraying where the softer metal forms the object, the body of it, as well as its superficial pores, will be penetrated by the harder metal with its projectile action. When the condition is reversed the softer spraying metal will fill the open pores of the harder object and key itself into the former in cooling off, but it will

TABLE II.—*Cost to Cover One Sq. Ft. by Spraying.*

Metal.	Diameter, inches.	Speed of wire per minute	Time to cover one square foot. Min.	Time to cover one square foot. Sec.	Thickness, inches.	Cost of spraying.	Cost of wire.	Total cost.
						d.	d.	d.
Copper	0.032	12	1	10	0.001	1.05	0.38	1.43
Brass	0.032	12	1	10	0.001	1.00	0.35	1.35
Bronze	0.032	12	1	10	0.001	1.20	0.50	1.70
German silver	0.032	12	1	10	0.0089	1.20	0.52	1.72
Aluminum	—	16	—	40	0.001	0.64	0.21	0.85
Zinc	—	18	—	30	0.0015	0.41	0.57	0.98
Lead	0.076	25	—	25	0.002	0.32	1.05	1.37
Tin	0.062	25	—	30	0.002	0.44	4.37	4.81

TABLE III.
Cost of Spraying One Pound.

Feet per pound	Speed of wire in feet per minute	Time to spray one lb. minute	Cost of spraying	Cost of wire	Total cost.
			d.	d.	d.
340	12	28	25.0	8.62	33.62
350	12	28	23 5	8.12	31.62
344	12	28	26.5	11.12	37.62
330	12	28	25 5	12 50	38 00
761	16	48	53.75	18.50	72 25
283	18	14	113.5	16.50	130 00
50	25	2	1.6	5.00	6.60
105	25	4	3 5	35.00	38.50

not penetrate the solid parts of the body. In either case, however, with proper preparation of clean, open surfaces a durable adherent coating is obtainable.

In general the applications of the process may be divided into five groups, viz., protective coatings; bonding or junction coatings; electrical coatings; decorative coatings; detachable coatings. It is with the first three of these that the engineer is chiefly concerned.

Protective coatings on steel or iron may be either original coatings of the whole of an object, or any part of it, or local applications with the pistol to repair damage or wear of a coating made by another process. The repair of the troublesome defects on galvanised sheets is an example. The localisation of copper deposits on iron and steel for the purpose of the cementation process and for controlling hardening is easily and quickly accomplished by the pistol. The results are reported to be much better than those obtained from the necessarily irregular and soft electrolytic deposits, the area of which cannot be absolutely controlled.

Many engineering structures used in the arts, such as steel and iron tanks, girders, and machinery of all descriptions, are subject to the action of liquids and chemicals and corrode rapidly, particularly at joints. It is not possible to plate such structures by any other coating method. In such cases a metal is selected which will resist the corroding agent, and is sprayed in the form of wire on all the seams and joints, these having previously been cleaned by sand-blasting.

Bonding or junction coatings can be freely applied to brick, metal or porcelain connections with the metal spray. The porosity of stone, both natural and artificial, lends itself readily to this use. The refractory hearths of furnaces using the surface combustion principle are readily bonded by the Schoop pistol to their porcelain or metal gas-conducting tubes by spraying the assembled parts with a metal of sufficiently high fusing point.

This is a single instance of the possibilities in bonding non-metallic surfaces. Though the pistol coatings are amorphous and vitreous throughout and are not calculated to carry the stresses of ordinary metal parts, there are many static uses of metal in which the Schoop coating is useful. The electric appliance field is one of these. Carbon in all its resistance forms can be freely sprayed with copper, and that metal can be applied in minimum quantity to any piece or portion of a piece of apparatus.

The most recent electrical application is the construction of condensers, especially for wireless service. The Schoop pistol will spray an adherent coat of copper on ordinary sand-blasted window glass. Two-thousandths of an inch is sufficient to produce a highly efficient and cheap plate much superior to rolled tinfoil coverings or galvanic deposits of copper on glass. Lead sprayed on glass also furnishes a very cheap and effective condenser plate.

It has been found that if the Schoop spray be turned upon a smooth greased surface of reasonable hardness, the bombarding fog of metal particles will remain upon the surface without impacting and will copy the surface to its finest line or detail. On cooling and tapping this reverse it detaches readily, and by using it as a mould and repeating the treatment with a film of grease, a detachable copy of the original object—a coin, medal or any relief subject—can be obtained in any desired metal.

Tables I. to III. show the data of gas consumption and total cost of spraying a square foot of some of the commoner metals by means of the Schoop pistol; also, the cost of spraying per lb. and by the hour and the rate of deposition.

A New Vanadium Steel.

To meet the requirement for a steel of greater strength for locomotive axles and forgings, railways in the past have turned to heat-treated carbon and heat-treated alloy steels, particularly chrome-vanadium steel. In the former, heat treatment has caused an increase of 20 to 25 per cent. in elastic limit over the annealed steel, but in chrome-vanadium axles an increase of 100 per cent. in elastic limit over the same steel annealed is specified and obtained by heat treatment. The relative cost of chrome-vanadium forgings, however, is high. The American Vanadium Company has developed a type of carbon-vanadium steel which without heat-treatment other than annealing meets the requirements specified for heat-treated simple carbon steel forgings of like section. These results are obtained, it is stated, from steel with lower carbon than is generally used to obtain the physical requirements for heat-treated carbon-steel locomotive axles and forgings. The cost of this steel is only a little higher than simple carbon steel. In the table which follows are given results of tests on axles and connecting-rod forgings from this new type of steel:—

Table of Tests of Simple Carbon-Vanadium Steel.

ANALYSIS: C. 0.47; Mn. 0.90; P. 0.012; S. 0.020; V. 0.15 per cent

Description.	Treatment.	Yield point, lbs. per sq. in.	Elastic limit, lbs. per sq. in.	Ultimate strength, lbs. per sq. in.	Elongation in 2 in., per cent.	Reduction of area, per cent.
7-in. axle	Natural ..	71,200	68,000	123,000	16.0	30.0
7-in. axle	Annealed 1,450deg.F.	56,000	52,000	90,000	24.0	50.0
7-in. axle	O. Q. 1,600; T.1,160deg. F... ..	85,000	82,000	112,500	22.0	55.0
11-in. axle	Natural ..	75,000	70,000	117,000	16.0	28.5
11-in. axle	Annealed 1,450deg.F.	58,000	54,000	94,000	22.0	47.0
11-in. axle	O. Q. 1,600; T.1,160deg. F... ..	87,000	80,000	115,000	20.5	52.0
Connecting rod!	Natural ..	92,000	85,000	131,000	17.0	44.0
Connecting rod	Annealed 1,450deg.F.	71,500	67,000	105,000	23.5	52.0
Connecting rod	O. Q. 1.600 T.1,160deg. F... ..	92,500	86,000	123,000	20.5	50.0

The method of annealing recommended is to heat the forgings uniformly at a temperature of 1,425 to 1,475 deg. F., remove them from the furnace, and allow them to cool in the air, protected from strong drafts and rain or snow.

GOVERNMENT USE OF REGISTERED DESIGNS.—By an amendment to an Order in Council under the Defence of the Realm Act, the Admiralty, Army Council or Minister of Munitions is empowered to authorise or require Government contractors or sub-contractors to use any registered design for the purposes of a contract without the consent of the registered proprietor, and the consideration to be paid for the use of the registered design shall, in default of agreement between the proprietor of the design and the Admiralty, Army Council or Minister of Munitions, as the case may be, be determined, at the option of the Treasury, either in the manner in which other claims for compensation under the regulations are determined, or in the manner in which the consideration for the use of a patent is determined under Section 29 of the Patents and Designs Act, 1907.

Notes on Steel Foundry Practice.

By J. Peers.

Not very long ago it was thought impossible to make very intricate castings in steel, but the improved methods that are now used in steel foundries have overcome many of the difficulties, and a few practical hints coming directly from the shop floor may be of interest to those engaged as steel founders.

When making intricate castings in steel the formation of the mould so as to give as little resistance as possible should be the first aim. This resistance can be largely obviated by making the moulds so that after certain parts are released the mould becomes practically collapsible. This saves stripping a casting to ease certain parts, for stripping a casting of a large size soon after pouring may possibly lead to a rupture.

Collapsible Moulds.

Drag or Bottom Part.—The boxes very frequently used in steel foundries are cylindrical, owing to the large number of locomotive wheels made of different sizes. There are generally a few of these boxes at liberty, so that the mould now to be described may be considered as being made in a round box of 5 ft. diameter. The required casting is a three-way expansion valve and the pattern is in halves. Of course the quickest way would be to turn it over off a board, but provision must be made for feeders coming through the bars. It is always safest to lay the cope part on the floor, turn it over and try the pattern on; then mark the cope where the feeders should come, fill up the cope with floor sand and strickle off a level bed; then set the bottom half of pattern to the marks previously made. The drag is composed of two parts and a bottom plate, although one part would be sufficient if deep enough. Plenty of bricks and ashes should be used, especially if any depth or width of sand is used, which is generally the case. Rods placed between flanges, brackets and the body of the pattern should be of wrought iron (not thicker than ¾ in.), because wrought-iron rods offer less resistance than cast-iron prods.

When the bricks are bedded in, a space should be left between each brick, so that ashes may be rammed between; if more than one layer of bricks and ashes are used, a thin layer of floor sand should be rammed between each layer, with connections in three or four places from one layer of ashes to the other, to facilitate the escape of gases when casting and prevent any escape of metal. Should a certain amount of metal force its way into the first layer of ashes, this layer of sand will prevent further escape; the sand also prevents explosions when casting, because it has the same effect as the gauze on a miner's lamp. These explosions will sometimes fracture a mould or core if this precaution is not taken, and may cause injury or loss of life. When the level of the drag part is reached, plates are used to cover the drag; these plates are packed and well clamped down to the box part and the whole lot is turned over.

The top half of the pattern is placed in position and the joint made. The joint at the prints is made differently for cast-iron moulding. At the end of each print a thickness piece is laid, and then sand is rammed up flush to the top of the core print; this is a continuation of the core print made of sand and carried back about 9 in. to 12 in. In some cases the box will not allow quite so much. This practice is followed whether the pattern is in halves or not, and the sand print is ironed to prevent it lifting in the cope. The thickness piece between the sand print and the print on the pattern is left in if of the proper size, but as this is not very often the case the piece is drawn out and in the space left parting or dry sand is placed, and a coating of parting sand placed over the sand print. The quickest way to make the job would be to have half the print in the cope and half in the drag, as is generally done in cast-iron moulding, but when lowering the core into the mould, by having all the prints made in the way illustrated, a good guide is given as to whether the core is in its proper position or not. The space left by the thickness piece allows the core to go down easily without any rubbing. A good vent from the core can now be drawn out and all spaces made good. No flash of metal should form round the ends of the core, as this renders waste the trouble of making a collapsible mould; for any flash prevents contraction. This form of making up prints will show why boxes have to be much larger than would otherwise seem necessary.

Cope or Top Part.—Two parts have to be used in the top part, one with traverses and one without. The one without bars is placed in position to fit pins if possible, and good strong bars are laid across this part. These bars should fit well across the box but not protrude so as to interfere when turning over the box. As the box is round, the bars have to be of different lengths and placed so that the feeders can pass through. On these bars lifters are hung, made from ¼ in. rod iron, and as the ramming proceeds about every two courses, rods, or tying pieces, are placed in the recesses and around the pattern. If there is a good depth or width of sand a few bricks and ashes will help very materially when drying the mould, not only by aiding the escape of gases, but by filling up portions of the mould that would otherwise carry damp sand.

The part with the traverses is now placed in position. This rests on the stout bars laid across the other part. If it should not fit dead on these bars they should be packed by thin pieces of iron packing (not wedged) after the two parts have been well clamped together. The feeders are fixed in so that a space of about 2 in. is left between the inside bars and feeders; if this is not allowed it prevents the contraction by being too close to the bars of the box. The remainder of the ramming is now completed and the heads drawn out. If the heads are of a large size, lids or tins are fastened across to prevent any sagging and falling to pieces by reason of the jar when turning the box over.

When the mould has been cast, the clamps are knocked off the two parts that constitute the cope, and then all parts of the mould are quite collapsible, there being nothing holding except the compo or sand between the bars and the feeders, and this is removed by a sharpened bar, for which reason the 2 in. space was left when fixing the feeders.

When castings of a heavier class are made, square or rectangular boxes made from sectional parts are used. To make these moulds collapsible a different method has to be adopted. Instead of lifters being hung from stout bars laid across the first part of the

cope, as in the above case, grids are used because much more weight of sand has to be carried. These grids are raised from the joint by "soldiers," or wooden blocks, from four to seven inches, to clear all parts that abut from the pattern. On these grids lifters are hung similar to those on the bars. If one part of the joint is deeper than another a difference in size of the wooden blocks will level the grids; thus different sizes of lifters are used. These grids must be kept well back from the pattern, but where a very wide flange occurs the wood blocks may rest on the flange and then the grid is over the flange. These wood pegs are afterwards drawn out and the mould made good where they have been. The grids are therefore practically level, whatever the shape of joint.

Ramming is proceeded with level to the grids to tighten the lifters. The same procedure is now followed as in all heavy work; packings are fixed on the grids according to width or length of the grids, and the S hooks linked in the grids. These S hooks and packings are carried forward as the ramming pro-

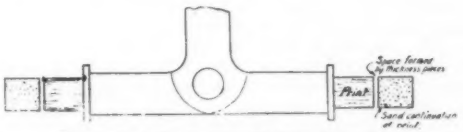


FIG. 1.—EXPANSION-VALVE CASTING.

ceeds until the level of the first part of the cope is reached. As two parts must always form the cope, instead of laying bars across to fit on the box edge they are laid across so that they rest on certain packings on the grids. If the pattern is of a dome-shape, lifters are hung from these bars resting on the packings and the whole rammed up level. The part is now placed in position, with the traverses or bars, and clamped or bolted well down to the other part. The strong bars resting on the packings are packed to the underside of the bars on the top half and also the remaining packings on the grids; the S hooks are linked with hook-bolts and fastened up by fishplates

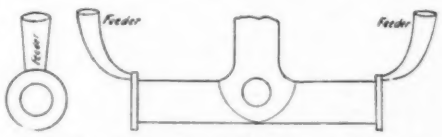


FIG. 2.—ALTERNATIVE FORMS OF FEEDING.

resting on the top side of the bars. As in the case of the valve mentioned before, the clamps or bolts are released after casting, the hook bolts released, and every part of the mould is then collapsible. The only easing to be done is between the bars and the feeders on the side nearest the centre of the box.

Drawbacks.

Another very important feature is the use of drawbacks. This is more pronounced in steel than iron founding, and, of course, in many cases takes up much more time than making a joint and carrying the deep lift in the top part or cope. But in all dry-sand work a clearance, more or less, has to be allowed when closing a mould with a deep joint, and this clearance will leave a fin, or flash of metal, which is always a source of danger in steel founding. The moulder's maxim, "a flash before a crush," is not sound in this case. The flash prevents the castings contracting, and is liable to cause a fracture. When a drawback is placed in its original position, after removing the pattern all clearances can be made good and no flash of metal occurs.

If two drawbacks are used in conjunction, a board should be placed where the division is required. This will make a clean job and allow for the expansion that always occurs when drying in the stove.

Fixing of Feeders.

Fig. 2 illustrates how by judicious placing of feeders work may be saved in the machine shop. The extra labour needed in fixing these feeders is counterbalanced by the saving in tools. For example, if the feeder on the expansion valve shown is fixed on the top of the flange, after cutting off as near as possible with the circular saw a surplus of metal is left that will have to be tooled to get the contour of the flange, while also the use of band saws is costly; but if the same valve had the feeders cut from the side of the flange, more area could be allowed for feeding, the castings would be much denser, and a straight cut with the saw would remove the surplus metal. As the boxes should be large enough to allow these heads to be fixed on the side of flange, the extra time taken, although put down to foundry costs, would be more than repaid eventually and the quality of the castings would be improved.

Phenomena of Solidification.

The different methods employed to meet the difficulties due to unequal distribution of metals are in many cases confusing. The same applies with all metals. To produce sound, dense castings is the aim of every foundryman, and always the densest castings are those made in dry-sand moulds, by reason of the

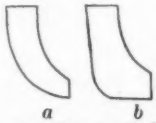


FIG. 3.—RIGHT (*a*) AND WRONG (*b*) FORM OF RUNNERS.

greater resistance to the metal when in the mould.

Chills, or "denseners," are often very strongly advocated for steel and iron founders, to lessen the troubles with the machine shop, especially. The writer's prejudice against them is not due to any conservative spirit, but results from an understanding of what can be done without them. At the best their use is only a hit-or-miss plan; and the use of denseners on high-class work is an attempt to cure an ailment that many suffer from, *i.e.*, as the use of surplus metal, and instead of curing the ailment more evil ones are created. The cost of the chills or denseners has also to be considered. They must be of the proper contour and a certain thickness; and when they are used a saving may be effected by having the denseners made reversible if of a circular design, which gives them a double life and costs no more. The writer has worked in foundries making the finest steel and iron castings where never a densener was used; they have been tried and found wanting, as they increase the evils of the foundry where the work is of the highest class.

Steel castings are considerably affected by denseners, and the effects are not apparent to the eye until the annealing has been done. If, on the other hand, much surplus has to be machined off, then the denseners are useful if thick enough; but they should only be used on work requiring machining or on rough castings.

Intricate castings that have to resist great pressures should, where sectional thicknesses join, be well bracketed according to size and shape. These brackets are placed in when moulding and the edge

of bracket that joins the casting should be made very sharp, to enable the fettler to knock it off easily. The brackets prevent pulling when the casting is cooling in the mould, but their greatest service is during the annealing process, and steel founders should not allow these brackets to be removed before annealing. As the temperature of the annealing oven is raised to certain points the different sectional thicknesses are not acted on as a whole, but independently. Therefore when the critical stage of the "lag," or the arrest on heating, is reached, the thinnest sectional parts lag, but the thicker parts do not at the same time. After this, the thin portions having expanded to their full limit, they have to withstand the pull of the larger sections. This critical stage is just as pronounced when cooling down, as the lag occurs when cooling just as when heating, but at different temperatures. Therefore the brackets left on the castings to some extent prevent distortion; but if chills are used to prevent pulling, and any sticking to the chills occurs, that part of the steel nearest to the chill is prevented from following its natural course and the annealing will release this, forming a weak spot, and a crack generally follows.

The critical expansions on rise and fall of temperatures during the annealing process will not allow chills or denseners to be used with any guaranteed success. For some work they have distinctive qualities, but they are accompanied by numerous defects.

The Tarring of Moulds.

Most moulds of a large size are tarred after drying. This is done whilst the moulds are very hot, just out of the drying stove. Many moulders when tarring a mould use tar as if blackwashing a mould. This is bad practice, apart from being wasteful, unless the surface is required to be hard wearing. Too much tar put on the face of the mould will give the casting an envelope of carbonaceous matter, and this is taken up by the casting. After annealing the casting is often rejected as unannealed, or if not rejected will not always fulfil the duties intended for it. This excess of tar acts exactly the same as too much coal dust in malleable cast-iron moulding. If too much tar has been put on, to destroy some of its effect, sprinkle the face of mould well with petroleum and put a light to it. This is a good method for burning off any surplus tar.

The Electric Furnace for Re-Heating and Annealing.*

By T. F. Baily.

The type of furnace apparently best adapted for re-heating operations is the resistance type in which the material to be heated is entirely separate from and independent of the resistance element in which the heat is generated by the electric current, making it extremely simple and convenient to operate. In some heating operations, the actual cost of heating per ton is less with the electric furnace than with combustion furnaces, while in some heat-treating and annealing operations, the precision with which the operations are carried out must be the justification for the higher cost of heating in the electric furnaces. In a general way, it is stated that the higher the temperature at which the heating operation is conducted, the higher the relative economy in the use of electric furnaces. The author sums up the principal advantages of electric furnaces for re-heating, as follows:—More accurate temperature control; non-oxidising atmosphere; saving in space; elimination of blast and stack; evenness of temperature throughout the heating space; simplicity of control; smaller amount of heat lost to the surrounding atmosphere; and cleanliness of surroundings. The smaller amount of heat lost to the surrounding atmosphere makes the work around an electric furnace, especially in summer months, far more healthy and agreeable than with the combustion furnace.

The thermal efficiency of electric furnaces varies with the size and capacity in tons per hour, a furnace of 1 ton per hour of 2,200 deg. showing an efficiency of 75 per cent. Most of the terminal troubles in electric furnaces for re-heating have been practically entirely eliminated; for example, one set of electrodes now lasts for months at a time in continuous service. For furnace temperatures not exceeding 2,500 deg. Fah., the electric furnace will answer any reasonable requirements, and, so far as actual fuel cost alone is concerned, at ½d. per kw.-hour, will compare favourably with oil furnaces burning oil at 2d. per gallon.

In large tonnages of heavy billets, the combination of a combustion furnace using producer gas up to 1,500 deg. Fah., and heating by electricity from this temperature to the desired rolling temperature offers the advantages of low fuel costs per ton of metal heated and a minimum amount of oxidation of the metal, beside protecting the electrodes. Such a furnace can be expected to show a thermal efficiency in the gas end of 50 per cent., and in the electric end of 75 per cent.

The author discusses, in some detail, the use of electric furnaces for soaking-pit and for heat-treating and annealing purposes. The type of furnace best adapted to heat treating is the automatic continuous furnace, where the metal under treatment when fired to the predetermined temperature is automatically discharged into the air or into some quenching medium. When the material at the discharge end of the furnace reaches the minimum temperature, a special pyrometer closes an electric circuit, which in turn closes, through a suitable relay, the solenoid-operated radial dial switch, and the various electrical circuits operate, in proper sequence, the doors, pusher and quenching apparatus.

In regard to the economy of small electric re-heating furnaces from the fuel point of view alone, where the current consumption per ton is 480 kw. and the rate is ½d. per kw.-hour, they can be compared with oil where the consumption per ton is 100 gallons at 2d. per gallon, or natural gas where the consumption per ton is 12,000 cub. ft. Electric furnaces of the continuous type, of 5 tons per hour capacity, will show a commercial economy over coal-fired furnaces of the same capacity with coal at 8s. per ton (requiring 200 lbs. of coal per ton of steel), while electric furnaces require an electric-current consumption of 250 kw.-hours per ton with current at ½d. per kw.-hour. The combined gas and electric furnace will show a commercial economy, compared with a producer gas-fired furnace using 200 lbs. of 8s. per ton coal, while the combination gas and electric furnace uses 140 lbs. of coal per ton of metal for heating it to 1,400 deg. Fah.

* From "Proceedings" of the Engineers' Society of Western Pennsylvania.

PETROL AND PATRIOTISM.—Under this title an interesting booklet has been issued by Bowring Petroleum Company, Limited, Finsbury Court, E.C. (the marketing agents of the Anglo-Mexican Petroleum Products Company, Limited), describing the numerous services which "Mex" motor spirit is rendering the country.

Waste in Hiring and Discharging Men.*

By M. W. Alexander.

If you take a works with 1,000 employés at the beginning of the year, and increase its permanent force to 1,100 at the end of the year, then theoretically under ideal conditions only 100 people should have been hired; but immediately we must make allowance for certain items, viz.:—(1) Men die, and they must be replaced. (2) Men fall sick, and are laid off for a longer or shorter period of time, at the end of which time, failing to return, they are discharged, and their places filled by others. (3) Men might be hired under proper conditions, with the proper judgment exercised in their selection, yet of their own accord they may not find it possible to remain in their positions, whether because of climatic conditions, domestic affairs, or other causes which necessitate their removing from the locality. (4) We must make a certain allowance for less than 100 per cent. of efficiency in the hiring department.

I believe that it must be assumed that only about 1 per cent. of the force of employés die; that about 5 per cent. leave the employ on account of sickness of more than two weeks' duration; that about 10 per cent. withdraw from the service or are eliminated from the service for whatsoever reason; and finally, I have assumed only 75 per cent. of efficiency for the hiring department. As to the 1 per cent. allowance for those who die, I have had recourse to insurance statistics and actuarial figures. Insurance statistics also show that less than 10 per cent. of the average works employés are sick annually for more than two weeks. I have assumed only a 5 per cent. rate because I know that, with respect to employés of some length of service, it is customary to keep them on the pay-roll even though without giving them any wage for a considerably longer period than two weeks. No reliable experience is available to show how many people withdraw during the year from whatsoever reason, or are asked to withdraw; but 8 per cent. of all employés in the Government Civil Service are separated from the Service annually, for reasons including sickness and discharge; or, excluding sickness, the figure is 4 or 5 per cent. I realise that the Governmental conditions are different from conditions in industrial establishments; I have therefore doubled the figure, and have taken 10 per cent. as the withdrawals by discharge, whether voluntary or involuntary.

Thus it is shown that you have to add 16 per cent., or 160 men, to the 1,000 in the works at the beginning of the year in order to show an increase of 100 at the end of the year. Then, again, taking into consideration that the efficiency of the hiring department is 75 per cent., that would furthermore increase the number of those taken on by about 40; yet the facts show that about 635 were actually engaged. So there appears to be no reason why 635 people were brought into this works and had to be broken into the ways of the plant in order to increase the force permanently by only 100. It is obvious that a considerable expenditure of money, effort and care must have been wasted in this respect.

I took a certain group of works and endeavoured to arrive at a financial valuation, for that purpose dividing the employés into different classes. I placed:—(1) In class *a* all highly skilled mechanics who have practised their trade for a number of years, having acquired it through apprenticeship with more or less regularity. (2) Under class *b* I included mechanics of lesser skill and experience who very likely could within one year acquire an average degree of efficiency. (3) In class *c* were included operatives who without any skill or experience soon acquired a sufficient degree of practical knowledge to do the work; such as pieceworkers whose time on probation is understood to be anywhere from 1 to 3 months. (4) Class *d* takes in all unskilled productive labourers who can be let go to-day and replaced by others to-morrow without great loss in the efficiency of the work. (5) In class *e* I put clerks, shop officers, shop room and labour department and cost-accounting officers. The managers of the various works were good enough to furnish me this information; and I classified the whole number, which covered more than 42,000, in that way.

I found that the increase between January 1 and December 31 had been 6,697, and that the total number who had been engaged for that purpose was 42,571. Applying the percentages which I mentioned before, and also the 75 per cent. efficiency of the hiring department, I found that only 17,596 should have been engaged; but even further allowing in the neighbourhood of 3,000 discharges or additional men hired merely due to conditions of production over which no one could have any control, I have by hook or crook brought the figure up to 20,350, which shows that in order to hire 6,697 people they took on in these plants 42,570, although the hiring of at least 22,220 could have been avoided if proper methods and means had been applied.

I think that the economic loss involved in the hiring and discharge of employés may be grouped under the following five heads:—(1) The clerical work of hiring. (2) The instruction of new employés by the foremen and assistants. (3) Increased wear and tear of and damage to machinery and tools by new men. (4) Decreased rate of production during the early period of productivity of the new men. (5) Increased amount of spoiled work by new employés.

Now let us take these five items and analyse them as to financial value. The clerical work in hiring labour is no doubt the smallest item. It includes interviewing the applicant. Various papers have to be made out when he leaves to make room for somebody else who of necessity has to be put in his place, and the whole process has to be gone over again. I think I am conservative in placing this item at 2s. per employé.

Instruction expense is very largely in amount dependent upon the nature of the work and the skill and experience of the new employé. This instruction expense will naturally be lowest in class *d*, the unskilled productive labourer, where the expense will be 4s. or 8s. each. It may be said that perhaps 30s. per employé will apply to class *a*, highly skilled mechanics who have had many years of experience behind them, and it surely will double, or amount to £3 per employé for class *b*. For class *e*, which includes clerks, the cost of instruction will be as high as for class *a*.

* From an address to the National Machine Tool Builders' Association, New York.

The value of the increased wear and tear and damage to machinery and tools is very difficult to estimate. The loss due to reduced production, of course, is entirely dependent on the value of the produced article. My guess, based on some investigation, is that unproductive labour may entail a loss in this direction of £1 per new employé, and the class of clerks in the various departments may entail a loss of £2 per new employé.

The expense due to the increased amount of spoiled work again depends entirely upon the value of the material and the work of the department. I cannot be very far amiss if I assign generally a value of £1 to the last three classes and a value of £3 to the first two classes.

On this basis there is a total of about £7 10s. loss per highly-skilled mechanic in new employment, about £12 loss for mechanics of lesser skill, about £13 for the average pieceworker, £1 14s. for the unproductive labourer, and £4 for the clerk.

In order to be as fair as possible, I have reduced the figures in all these classes to about one-quarter to one-half the values above given, and in multiplying now the number of people in each grade by the financial value here assigned I have the astonishing result that the 22,220 employés, who after making all kinds of allowances were unnecessarily engaged, meant an average loss through their engagement of somewhat over £7 per man to this group of works, or an actual loss of over £150,000 in one year, which amount represents a very considerable percentage of the profits of the various concerns.

How to Reduce the Loss.

Assuming that these figures are fairly correct, we are immediately faced with this question: How can this loss be avoided, if not entirely, at least in part? To this question I think five answers present themselves. (1) A careful study of current employment statistics should be made, and an analysis of the reasons for the discharges. (2) We need a far higher grade of men in charge of the hiring and discharge of men than we have had heretofore in our employment clerks. (3) While it is important to exercise proper care, thought and study in the hiring of employés, it seems vastly more important to apply the proper methods in initiating new employés in the work, and to treat them properly. (4) We ought to have effective systems of apprenticeship, factory schools, and special training courses. The problem seems to be of a somewhat international character. Let me give a few illustrations drawn from works experience in Germany and England in respect to this question:

A works which had 13,556 employés at the beginning of the year and 16,450 at the end of the year, an increase of 2,894, or 12¼ per cent., engaged 9,530 people in order to secure 2,894, or in other words 3 times as many; a fairly good condition.

Coming down to a smaller works still, at the beginning of the year they had 4,636 people, at the end of the year 5,270, an increase of 634, or 13.75 per cent. This required the engaging of 4,845 employés, or 7¾ times the increase in the staff at the end of the year.

A large German works at the beginning of the year had 10,998 employés; at the end of the year 11,914, an increase of 916, or say 8.5 per cent.; and it engaged 17,059 employés, or 18½ times the increase; a figure so astonishing for a concern priding itself upon its fine organisation that I got permission from the president of the company to go over the books myself and checked it to the very last figure, finding the above correct.

An English works which stands high among English manufacturing concerns, at the beginning of the year had 3,158 people employed; at the end of the year they had 3,149, or nine less than they started with; yet 2,148 people were required to be taken on to obtain the minus result.

Iron and Steel Institute.

Autumn Meeting, 1915.

The Autumn Meeting of the Iron and Steel Institute will be held, by kind permission, at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday and Friday, September 23 and 24, commencing at 10.30 a.m. on the 23rd and at 10 a.m. on the 24th. In the absence of Mr. Greiner, Mr. Arthur Cooper, LL.D. (immediate Past-President), will preside at the meeting. The following is the list of Papers that are expected to be submitted for reading and discussion:—"Influence of Oxygen on Some Properties of Pure Iron," by Wesley Austin, M.Sc.; "Note on the Carburisation of Iron at Low Temperatures in Blast Furnace Gases," by T. H. Byrom; "Influence of Heat-Treatment on the Specific Resistance and Chemical Constitution of Carbon Steels," by Professor E. D. Campbell; "Effect of Chromium and Tungsten Upon the Hardening and Tempering of High-Speed Tool-Steel," by Professor C. A. Edwards, D.Sc., and H. Kikkawa; "Phosphorus in Iron and Steel," by W. H. Hatfield, D.Met.; "The Magnetic Transformation of Cementite," by Professor K. Honda and H. Takagi; "Sulphur in Malleable Cast Iron," by R. H. Smith; "Iron and Nitrogen," by Professor N. Tschischewski.

In accordance with Rule 20 of the present bye-laws:—"No alterations of the bye-laws shall be made except at the Annual General Meeting and notice of any proposed alterations shall be given at the General Meeting to be held in the autumn." The Council therefore announce that at the Autumn Meeting, to be held on September 23—24, at the Institution of Civil Engineers, London, they will give formal notice of their intention to submit to the Annual Meeting in May, 1916, the following new rules for addition to the existing bye-laws:—(1) In the event of a state of war existing between Great Britain and any other country, or State, all members, honorary members, and honorary vice-presidents who shall be subjects of such enemy country, or State, shall forthwith cease to be members, honorary members, or honorary vice-presidents of the Institute, but they may, if the Council think fit, be reinstated after the termination of the war. (2) The Council shall have absolute power to remove from the list of Members of the Institute the name of any member, whether ordinary or honorary, for wilful contravention of the bye-laws or for any other reason which seems to them sufficient, and such ordinary or honorary member shall thereupon cease to be a member of the Institute.

BRITISH FOUNDRYMEN'S ASSOCIATION.—LONDON BRANCH.—On Saturday, August 14, the annual meeting of the London Branch of the British Foundrymen's Association was held, when the election of officers for the 1915-1916 session took place. Mr. A. Willis was elected President and Messrs. A. R. Bartlett and T. W. Aitken senior and junior Vice-Presidents respectively. Owing to the absence, through indisposition of Mr. A. Willis, the Presidential address was deferred until the next meeting of the Branch. Following the formal business the members held a social evening and impromptu concert.

Electric Melting of Ferro-Chrome.*

By Robert M. Keeney.

More ferro-chrome is manufactured in the electric furnace than any other ferro-alloy except ferro-silicon. Some experiments were made by the writer in 1912 on the production of ferro-chrome from chromite with carbon as a reducing agent. In these experiments, contrary to the usual practice in ferro-chrome manufacture, lime was used as a flux, to show its desulphurising and dephosphorising effect with an ore not so pure as the usual ore used in ferro-chrome production. In usual practice only the purest raw materials available are charged, so as to avoid the excess slag caused by adding lime. The only slag formed is from the coal or coke and chromite.

The conclusions drawn are, first, ferro-chrome can be easily manufactured directly from chromite in the electric furnace; second, the percentage of carbon in ferro-chrome cannot be kept low by regulating the carbon charged without excessive loss of chromium in the slag; third, the percentage of carbon in the ferro-chrome must be regulated by decarburisation with an oxide slag of iron or chromite after the slag from reduction has been tapped off; fourth, the proportions of silicon and phosphorus cannot be kept low in the alloy under the strong reducing conditions necessary; fifth, sulphur can be easily slagged; sixth, as the addition of lime does not seem to aid in reducing phosphorus, it is advisable to use no lime but raw materials as pure as possible; and seventh, the power consumption should not exceed 3.7 kilowatt-hours per lb. of ferro-chrome tapped or 0.85 kilowatt-year per ton.

In the reduction of chromium from chromite to form ferro-chrome with the iron reduced, reduction of chromic acid begins at 1,185 deg. C. Reduction takes place according to the reaction:—

$$FeO.Cr_2O_3 + 4C = Fe.2Cr + 4CO.$$

A pure chromite ore contains 68 per cent Cr_2O_3 and 32 per cent. FeO. For reduction of pure chromite 30 parts of carbon are theoretically necessary for every 100 parts of iron and chromium reduced. In practice this amount is exceeded considerably. In ferro-chrome manufacture practically all of the reduction is performed by the solid carbon and not by carbon-monoxide gas. On the basis that the double carbide $Fe_3C.3Cr_3C_2$ forms in reduction with carbon, as has been found to be the case, the reduction reaction is as follows:—

$$9FeO.9Cr_2O_3 + 50C = [2(Fe_3C.3Cr_3C_2) + 3Fe] + 36CO.$$

The ferro-chrome resulting would contain theoretically 10.4 per cent. carbon, 31.4 per cent. iron, and 58.2 per cent. chromium. For reduction of 100 parts of this alloy 37 parts of carbon are necessary, the above reaction explaining the difference between the theoretical and the practical proportion of carbon necessary, if calculation is made on the assumption that the double carbide is not formed.

Decarburisation of high-grade ferro-chrome is accomplished by melting the alloy with a slag of lime, chromite ore, and a little fluorspar. For each 100 parts of completely decarburised alloy 39 parts of pure chromite ore are necessary, or for each 100 parts of ferro-chrome containing 10.6 per cent. carbon, 31.3 per cent. iron, and 58.1 per cent. chromium, 36 parts of pure chromite ore are necessary for complete decarburisation. The resulting alloy would contain 66.6 per cent. chromium and 33.4 per cent. iron. In practice the lime is added simply to flux any silica in the ore, to assist in elimination of silicon in the ferro-chrome, and to cause possible removal of carbon as calcium carbide, as the operation is performed in an arc furnace. The fluorspar makes the slag more fluid.

Until the introduction of the electric furnace in 1899 ferro-chrome was manufactured entirely in either the crucible or the blast furnace. In the blast furnace chromite is reduced with some difficulty, with the high fuel consumption of about 3 tons of coal or coke to 1 ton of ferro-chrome produced. Little ferro-chrome is now made by either the crucible or the blast furnace, because it can be made cheaper in the electric furnace in localities where electric power is cheap.

The analyses of some of the ores used are given below:—

TABLE I.

Component.	Source of ore. Turkey.	New Caledonia.	California.	Cuba
	Per cent.	Per cent.	Per cent.	Per cent.
Cr_2O_3	51.7	55.7	52.68	50.0
FeO	14.2	13.2	15.30	18.57
Al_2O_3	14.1	16.2	11.40	12.44
MgO	14.3	9.8	16.23	13.38
SiO_2	3.5	0.2	3.40	3.82
CaO	1.7	0.25	—	2.16
H_2O	0.3	1.05	0.94	—
MnO	—	0.2	0 15	—
S_2O_4	—	0.05	—	0.45
d	—	—	—	0.69

Manufacturers use only chromite containing less than 0.1 per cent. phosphorus and sulphur and about 50 per cent. Cr_2O_3. They use no lime in the charge, as it has been found preferable by them to use pure materials and keep the amount of slag as low as possible. In most plants high-grade anthracite coal is used as the reducing agent. Coke or charcoal may be used instead of anthracite coal, but the latter is better, as it may be obtained in a more finely pulverised state, a form in which it makes a more intimate contact with the chromite, and consequently produces a better reduction.

There are several types of electric furnace used in the manufacture of ferro-chrome, usually similar to the Héroult steel furnace with vertical electrodes in series. The process of manufacturing ferro-chrome consists of mixing a charge of chromite and anthracite coal in proportions based upon the theoretical calculations given. The charge is shovelled into the open top of the furnace and around the electrodes.

Ferro-chrome containing as low as 5 per cent. carbon can be made economically when produced directly from ore in one operation. It has been possible to produce an alloy containing as low as 2 per cent. carbon in one operation, but great care in regulation of the charge and operation of the furnace is necessary. The slags from the average ferro-chrome furnace making a 5 per cent. carbon alloy run from 0.5 to 1 per cent. Cr_2O_3.

The refining of the high-carbon grades of ferro-chrome is done in an arc furnace, where the alloy is subject to a prolonged heating with a slag of chromite, lime and fluorspar, proportioned to the amount of carbon and silicon to be removed and the silica that must be fluxed in the chromite used. The

*From a report to the U.S. Bureau of Mines.

ferro-chrome covered by this slag is heated at a high temperature for a length of time dependent on the carbon in the alloy. The resulting slag contains about 25 per cent. Cr_2O_3, and is ground up and sent through the smelting furnace again, so that there is not much loss of chromium. By this method it is

TABLE II.—*Analyses of Typical Ferro-Chromes.*

Component.	Electric furnace.				
	With 8 to 10 per cent. carbon.	With 7 to 8 per cent. carbon.	With 5 to 6 per cent. carbon.	With 3 to 4 per cent. carbon.	With 1 per cent. carbon.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Chromium	64.5	63.5	64 0	64.0	63.5
Iron	22.0	21.5	28.5	31.0	35.0
Carbon	9.5	7.5	5.5	3.5	0.6
Silicon	2.25	5 8	0.4	0.3	0.2
Aluminium	0.80	0.8	0.5	0.4	0.10
Manganese	0.15	0 15	0.15	0.15	0.10
Calcium	0.25	0.25	0.25	0.30	0.35
Sulphur	0.04	0.04	0.04	0.04	0.03
Phosphorus	0.03	0.03	0.03	0.02	0.02

possible to reduce the carbon from 10 to 0.25 per cent., but the more usual low-carbon grade contains 0.5 per cent. carbon. The percentage of carbon in the ferro-chrome varies from 9.5 to 0.6 per cent., but the iron increases with the decrease of carbon. This would seem to show that in refining, the iron oxide of the chromite is first reduced, the chromic oxide merely serving to keep a slag with excess chromium, thus preventing any final lowering of the percentage of chromium in the alloy. As the carbon is oxidised so is the silicon until the content is as low as 0.2 per cent., as compared with 2 to 5 per cent. in the crude alloy. Aluminium is also considerably eliminated and phosphorus and sulphur are reduced to a slight degree.

Processes based on the use of silicon or some reducing agent other than carbon have not been commercially successful, because the cost of such reducing materials as silicon, ferro-silicon and aluminium is much higher than that of carbon. Also the products may be contaminated with the reducing material just as when carbon is used, so that a subsequent refining is necessary. Carbon-free ferro-chrome for high-grade steels has, however, been successfully made by the thermit process, but the amount made in this way is comparatively small. Analyses of various grades of ferro-chrome are given in Table II.

Power Consumption.

The power consumption in a ferro-chrome furnace of the Meraker Electric Smelting Company at Kopperaaen, Norway, was recently given as 3 kilowatt-hours per lb., or 0.68 kilowatt-year per ton of 2,000 lbs. in making a ferro-chrome containing 5 per cent. carbon. At Kanawha Falls, W. Va., ferro-chrome was made in a crucible electric-arc furnace with a power expenditure of 3.6 kilowatt-hours per lb. or 0.72 kilowatt-year per ton. This product contained 70.96 per cent. chromium, 23.23 per cent. iron, 5.21 per cent. carbon, 0.5 per cent. silicon, 0.008 per cent. phosphorus, and 0.078 per cent. sulphur. At both Kopperaaen and Kanawha Falls an ore containing about 50 per cent. Cr_2O_3 was used. The Kopperaaen ferro-chrome contains 65 to 70 per cent. chromium. In the experiments of the writer, a product containing 50 to 68 per cent. chromium and 4.32 to 9.31 per cent. carbon was obtained with an ore containing 46.35 per cent. Cr_2O_3, and power consumption of 3.02 kilowatt-hours per lb., or 0.69 kilowatt-year per ton. A 750-kilowatt furnace at Kopperaaen is of the Alby carbide type.

In Table III. estimates are made of the cost of manufacture of a ferro-chrome containing 60 per cent. chromium and 8 to 10 per cent. carbon from chromite ore containing 50 per cent. Cr_2O_3. The calculations are on the basis of two 750-kilowatt furnaces turning out a total of 6 tons of ferro-chrome per 24 hours. The Norwegian plant is within 60 miles, the French plant within 200 miles, and the American plant assumed to be within 100 miles of seaboard. Labour conditions are considered to be as found in the various countries.

The figures indicate that it costs 39.2 per cent. more to manufacture ferro-chrome in the United States than in Norway. This increase is due to the higher price of power and increased labour cost. The cheapest figure at which power can be obtained now in the eastern United States is £5 11s. per kilowatt-year for electro-metallurgical purposes.

TABLE III.—*Cost of Production of Ferro-Chrome per net ton.*

	Norway.	France.	United States.
	£ s. d.	£ s. d.	£ s. d.
3,000 pounds of chromite ..	4 5 5	4 13 9	4 13 9
500 pounds of coal	0 5 2½	0 6 3	0 5 2½
50 pounds of carbon electrodes ..	0 8 4	0 6 3	0 8 4
0.68 kilowatt-year	1 3 6½	2 12 11	3 13 6½
Labour	1 14 8½	1 7½ 9	3 9 2
Repairs	0 16 8	0 16 8	0 16 8
Amortisation and depreciation at 5 per cent. each	0 10 5	0 10 5	0 10 5
Interest on 50,000 dols. at 6 per cent.	0 6 3	0 6 3	0 6 3
General and packing	0 16 8	0 16 8	0 16 8
Total	10 7 2½	11 16 11	15 0 0

Ferro-chromes containing less than 2 per cent. carbon are used in the manufacture of tool steels. The alloys containing 3 to 6 per cent. chromium are used principally in the manufacture of steel castings.

For the manufacture of armour plate and projectiles, the high-carbon ferro-chromes containing 8 to 9 per cent. carbon are generally used. This alloy is cheaper. A ferro-chrome containing a high proportion of carbon used in the open-hearth furnace will give a yield superior to that containing a low proportion of carbon, because if the metal is still slightly oxidised, the oxide will act on the carbon rather than on the chromium. For the purpose of protecting the chromium from oxidation, armour-plate manufacturers sometimes use a ferro-chrome that contains a high percentage (4 to 5 per cent.) of silicon. In this way the oxides act on the silicon before they act on the chromium.

In armour-plates the nickel and chromium are sometimes added in the form of a ferro-chrome-nickel containing 52 per cent. chromium, 18 per cent. nickel, 28.96 per cent. iron, 0.5 per cent. carbon, 0.5 per cent. silicon, 0.03 per cent. sulphur, and 0.01 per cent. phosphorus.

STANDARD STEEL SPECIFICATIONS FOR MOTOR-CAR CONSTRUCTION.—A good deal of valuable work is being done by the American Society of Automobile Engineers in the way of arriving at standards for the various components that enter into the construction of motor-cars. The enquiries relate to practically every part of automobiles, each being carried out by a separate committee. The committee which deals with iron and steel has just issued a pamphlet of nearly 50 pages giving specifications covering the entire chemical composition of some 45 different steels under the general classification of carbon steels, nickel steels, nickel-chromium steels, chromium steels, chrome-vanadium steels and silico-manganese steels.

Die-Casting of White Alloys.*

By John C. Work.

In 1908 the author was called upon to take charge of a die-casting business for the manufacture of small parts of various machines and appliances which ordinarily required a good deal of machine work. The process by which these parts were to be made was supposedly a secret one, which had been brought from France. Abroad, according to the best information obtainable, this plant was turning out not only small articles made of white metal, but had even succeeded in casting aluminium crank cases for automobile engines which were so perfect that they could be fitted together without any machine work whatever. Although this state of perfection was never realised in our work, many small articles were successfully cast in white metal, accurate to 0.002 in. While this is being done at the present time by several small concerns, the process used by them calls for the application of pressure to the molten metal in order to force it to fill the moulds completely. The French process with which the author was connected, did not require any pressure other than that afforded by approximately a 6-in. riser in the die itself.

The chief reason for the lack of financial success of our company was the inability of the French workmen to realise the value of time in American business methods, coupled with lack of capital to install the apparatus which experiments led the management to believe necessary.

While the actual composition of the alloy used in France was supposed to be a profound secret, known only to the one Frenchman who brought it to this country, the author found that any of the numerous so-called "white metal" alloys may be cast satisfactorily to the above-mentioned accuracy, with a very small percentage of failures. The intricacy of the casting appears to be limited chiefly by the skill required in the manufacture of the die. The die should be made from highest grade, grey cast iron. The workmanship must be of the very best, and all the parts going to make up the complete die must be capable of being taken apart and assembled with a minimum amount of labour. They must have numerous vents to permit the escape of gas from the cooling metal.

A good deal of the success in making castings seemed to lie in having the molten metal at the correct temperature; if too hot, it did not seem willing to take the exact form of the mould, and if too cold it would not flow with sufficient freedom to fill the intricacies. If poured at the right temperature, there was no trouble in casting the thread on bolts from ¼-in. diameter up. Before pouring the metal, the moulds were heated, and then plunged into a tub containing water and whiteing, which was kept in a state of suspension by stirring. This dipping was followed by another heating of the moulds. When the moulds had reached a proper temperature, which was entirely a matter of judgment on the part of the man handling them (testing the temperature as a woman tests the heat of a flat-iron), the metal was poured. The small castings, which were most successful, cooled enough to be taken from the mould in a very few minutes. This process was repeated, dipping the moulds after every three or four casts.

One of the chief fields for this class of work was originally thought to be in carburetters. While we were quite successful so far as turning out the parts and fitting them was concerned, no one realised, or knew from experience with the metal used, the effect of petrol upon it. While in the liquid state, petrol apparently had little or no effect, but when vaporised, or when just vaporising at the spray plug, it acted on the metal with the formation of a white deposit. This deposit was never analysed, but much resembled zinc oxide in appearance. The deposit, however, rapidly caused the suspension of ignition and the entire carburetter had to be taken down and cleaned. In the small plant, and using hand moulds, we were never able to cast an alloy running high enough in aluminium to make any material difference as to the effect of petrol vapour.

While the author does not believe that aluminium in anywhere near a pure state can be cast in dies without using pressure, he believes that with proper ovens in which to heat the dies, and with the use of pressure to force it into them just at the moment of solidification, die castings can be made which will far surpass in accuracy any aluminium castings yet produced.

A few attempts were made to cast brass in dies, but they were not satisfactory. While occasionally a perfect thread would be obtained, there was apparently too much gas in the metal. This trouble was lessened, but not wholly overcome, by increasing the number and size of the vents in the die.

A considerable amount of experiment proved that the die-casting process, as carried on, was not particularly satisfactory, chiefly owing to the expense of making the dies for small orders.

* "School of Mines Quarterly."

American Government Bronze.

The following specifications, presented at the recent annual meeting of the American Society for Testing Materials, by the Committee on Non-Ferrous Metals and Alloys, cover the alloy commercially known as Government bronze, Admiralty gunmetal, gunmetal, or 88-10-2 mixture, when used in castings.

It is recommended that this alloy shall not be used where castings are subjected to a temperature exceeding 260 deg. C. (500 deg. F.). The alloy may

Fig. 1.—American Government Bronze Test Bar

be made by any approved method, but shall conform to the following requirements as to chemical composition:—

	Per cent.
Copper	87 to 89
Tin	8 to 11
Zinc	1 to 3

The sample for chemical analysis may be taken either by sawing, drilling or milling the castings or tension test specimen and shall represent the average cross-section of the piece. The saw, drill, cutter or other tool used shall be thoroughly cleaned. No lubricant shall be used in the operation and the saw dust or metal chips shall be carefully treated with a magnet to remove any particles of iron derived from the tools.

The alloy shall conform to the following minimum requirements as to tensile properties:—

Tensile strength, 33,000 lbs. per sq. in.
Elongation in 2in., 14 per cent.

Two test bars of the form and dimensions shown in Fig. 1 shall be an integral part of large castings,

or cast separately in the case of small castings to represent a lot or melt and shall be moulded in a manner similar to the castings which they represent. If the castings are heat-treated, the test bars representing such castings shall be similarly heat-treated.

The manufacturer and purchaser shall agree whether test bars can be attached to castings, on the location of the bars on the castings, on the castings to which bars are to be attached, and on

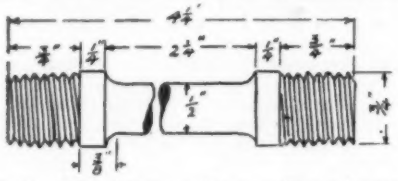


FIG. 2.—TEST SPECIMEN TURNED DOWN FROM TEST BAR.

the method of casting unattached bars. Unless otherwise agreed upon, the minimum lot shall be considered as 500 lbs.

The tension test specimen, turned down from the test bar shown in Fig. 1, shall be of the form and dimensions shown in Fig. 2.

Two tension tests shall be made from each lot or melt. If any test specimen shows defective machining or develops flaws, it may be discarded; in which case the manufacturer and the purchaser or his representative shall agree upon the selection of another.

If the purchaser's tests show that the material does not conform to the requirements, the manufacturer shall have the opportunity to inspect the material and each party shall select a sample for re-test. If the results do not agree each shall select a sample to be sent to a mutually agreeable umpire, whose decision shall be final. The costs of re-tests shall be paid by the loser.

American Malleable Cast-Iron Specifications.

At the recent annual meeting of the American Society for Testing Materials, revised standard specifications for malleable-iron castings were considered.

The committee, in presenting its report, stated that another change in these standards undoubtedly will be made which will involve specific standard specifications for malleable castings intended for definite classes of work. It was pointed out that malleable-iron castings for different purposes often require diametrically opposite properties, but such castings are usually made from the same heats in many establishments attempting to turn out work to specifications. The revised standard specification, which is reproduced herewith, was submitted to letter ballot for adoption. These specifications are intended for general use, and in particular for railroad malleable-iron castings, for which purpose they will be designated when additional specifications for other classes of malleable iron castings shall have been adopted.

The castings shall be made from iron melted in either an air, open-hearth or electric furnace.

Tension test specimens shall conform to the following minimum requirements as to tensile properties:—

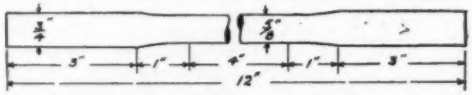
Tensile strength, 38,000 lbs. per sq. in.
Elongation in 2 in., 5 per cent.

Transverse test specimens, tested with the cope side up on supports 12 in. apart, pressure being applied at the centre, shall conform to the following requirements as to transverse properties:—

Thickness of specimen, in.	Minimum load applied at centre, lbs.	Minimum deflection at centre, in.
½	900	1.25
⅝	1,400	1.0
¾	2,0 0	0.75

In addition to the tension and transverse tests, the inspector representing the purchaser may satisfy himself of the suitability of the iron used for the castings by breaking a reasonable number of castings before annealing, to examine for excessive mottling or graphite spots. In the case of castings of special design or importance, he may also require test lugs of a size proportional to the thickness of the casting, but not exceeding ½ to ¾ in. in section. At least one of these lugs shall be left on the casting for final inspection.

Tension test specimens shall be of the form and dimensions shown in the accompanying illustration.



Transverse test specimens shall be 14 in. in length by 1 in. in width and either ½, ⅝ or ¾ in. in thickness. The thickness of the specimen selected shall be in proportion to the thickness of the casting which it represents.

Two tension and two transverse test specimens shall be cast in each mould with risers of sufficient height at each end to secure sound bars. All specimens shall be cast without chills, and with ends perfectly free in the mould.

Four moulds shall be poured to represent each melt. When the entire melt is used for castings which are subject to these specifications, two moulds shall be poured within five minutes after tapping into the first ladle, and two moulds from the last iron of the melt. When only part of the melt is required for such castings, two moulds shall be poured from the first ladle of iron used and two moulds after the required iron has been tapped. The moulds shall be suitably stamped to identify the specimens.

The test specimens from one mould from the first and one mould from the last of the melt shall be annealed in the hottest part of the annealing oven, and the remaining specimens shall be annealed in the coldest part.

One tension and one transverse test specimen from each of the four moulds representing a melt shall be selected for test. The remaining specimens shall be reserved, and shall be tested in case of failure to conform to the requirements specified.

If more than one tension or transverse test specimen from each of the two moulds annealed in the two points in the oven fail to meet the requirements as to tensile or transverse properties, the castings from that melt will be rejected.

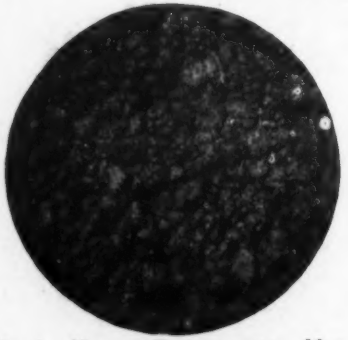
The castings shall substantially conform to the sizes and shapes of the patterns, and shall be made in a workmanlike manner. A variation of $\frac{1}{32}$ in. per foot will be permitted. The castings shall be free from blemishes, scale and shrinkage cracks.

The inspector representing the purchaser shall have free entry at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to consignment.

Tests of Foundry Sands for Refractory Values.

By A. L. Curtis, M.E.

Material Tested :—**NOTTINGHAMSHIRE SAND (Mansfield Fine).** *Weight of Sample*.—100 Grammes. *Colour and Description* :—Darkish brick Red. *Consistency* :—Medium-Strong, Fine. *Surface Factor or Size* (Grammes per cent.).—Retained on 50 Sieve, Nil ; Retained on 100 sieve, 40.550 : sieved through a 100 Sieve, 59.450. *Water Required for Maximum Cohesiveness when Dried* 1 *Hour at* 100 *deg. cent.* :—4.50 C.C. per cent. *Venting Capacity of* 1 *Cub. In. when Mixed* 400 *Times with* 4.50 *per cent. Water and rammed at a Pressure of* 20 *lbs. per sq. in.* :—About 6 lbs. air pressure. *Plate* :—Wellington-Ward "Anti-Screen" *Objective* :—1" Watson.



No. 1.—Normal Temperature. Mag. × 50 Diams.

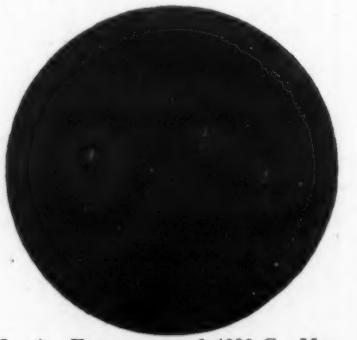
Remarks.—Material Strong and Fine. Works Well in Moulds.

No. 2.—Exposure to 1,200° C. Mag. × 50 Diams.

Remarks.—No Expansion in Test Piece. Specimen Strong. Bleaching out of Clay Substance Begun.

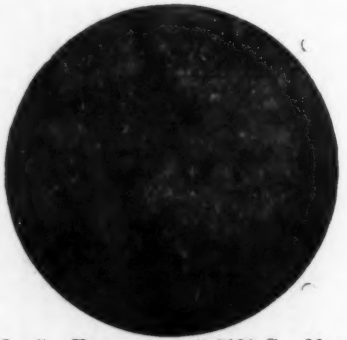
No. 3.—Exposure to 1,300° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded $\frac{1}{16}$ in. in the Form of a Camber in a Length of 2½ in. Specimen Strong. Finer Grains Begun to Fuse Together in Small Bunches of Aggregates.



No. 4.—Exposure to 1,400° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded as in Fig. 3. Specimen Strong. Material Fused in Larger Bunches or Aggregates showing Deep Fissuring by Iron, etc.



No. 5.—Exposure to 1,500° C. Mag. × 50 Diams.

Remarks.—Test Piece Expanded as in Fig. 3. Material nearly Completely Fused, showing Fissuring and Pitting.

No. 6.—Exposure to 1,600° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Exfoliation Begun. Material Completely Fused to a Dark-Grey Glass, showing Heavy Fissuring and Pitting.

No. 7.—Exposure to 1,700° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. More Exfoliation. Material Fused much Deeper in Specimen to a Dark-grey Glass.

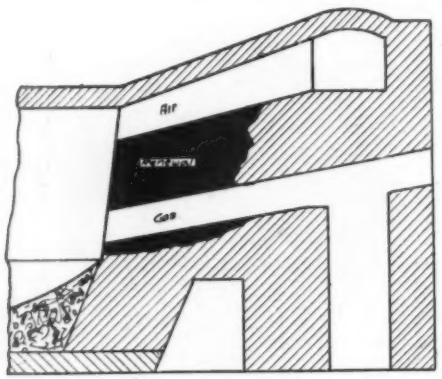
No. 8.—Exposure to 1,800° C. Mag. × 50 Diams.

Remarks.—Test Piece Broken by Heat. Much more Exfoliation. Specimen Weak. Material Completely Fused all over Face of Test Piece to a Dark-grey Glass.

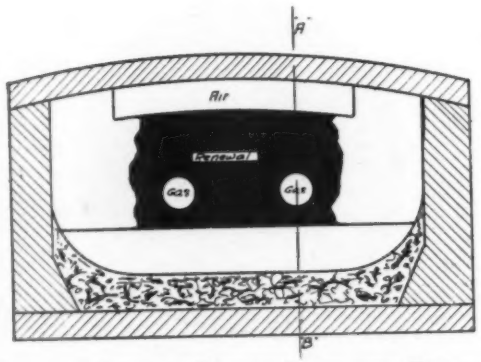
Protection of Open-Hearth Furnace Blocks and Ports.

One of the most common troubles connected with the operation of furnaces of the Siemens-Martin type is the loss and delay occasioned by the burning away of the blocks between the gas and air ports. Existing designs of furnace blocks are hampered by the necessity of building sufficient length to allow for burning away, which length may be regarded as the measure of the continued and uninterrupted use of the furnace. Thus each furnace starts under conditions in which the efficiency increases up to the best point of the block, after which it begins to decrease until the time for shutting down arrives.

This burning away of the blocks also affects the



Section at AB.



Sectional Views of Furnace Ports after Renewal.

angle at which the flame impinges upon the bath, and on the other hand alters the angle taken by the exit gases escaping into the regenerators. The result is to cause the furnace to work irregularly and with variable efficiency. In other words, there is a definite relation between the gas and air ports, and a definite length which every furnaceman knows to be the best and most efficient for his furnace. Obviously, therefore, the ideal attainment would be a block where the ports maintained a definite relation to each other, by which means the efficiency would be more or less constant, with complete regularity in the working.

With the desire of obviating these troubles and while recognising the merits of the existing types of melting furnace—which through long years has been brought to its present perfection—the Clyde Furnace Company ("A"), Limited, of 38, Bath Street, Glasgow, have introduced a system of construction in which the aim has been to retain the existing construction without alteration, and to provide a method whereby the existing blocks and ports could be maintained in a more or less constantly perfect condition, so that, without the necessity of shutting down the furnace or losing a cast, the blocks could be renewed, as necessity arises, up to their original or any other desired length—the length, in fact, which in practice is found to be the most suitable for efficient and regular working, while causing a minimum of damage to furnace roofs and walls. The invention also enables furnace blocks to be rebuilt to the fastest working point, inasmuch as they can be kept in constant repair, thus ensuring constant, regular and efficient working, and obviating the necessity of extended ports with long blocks, which, for the purpose of prolonging the working of the furnaces, have hitherto been adopted, notwithstanding recognised objections.

It is claimed that, by the adoption of this system, furnaces which, under the ordinary system, would require to be shut down owing to the burning away of the blocks, can have their ports renewed without shutting down, and without the employment of a special staff or costly material, thus eliminating what at present forms a more or less costly element in the annual upkeep of a furnace, for instance:—(*a*) Additional gas required due to faulty condition of ports and the gas spreading; (*b*) labour and material to be employed in the rebuilding of blocks; (*c*) loss in fuel due to the cooling down and re-heating of the furnace; (*d*) damage to the furnace linings caused through contraction and expansion due to the cooling and re-heating; and (*e*) loss of output due to the shutting down of the furnace through block troubles—so many days per annum.

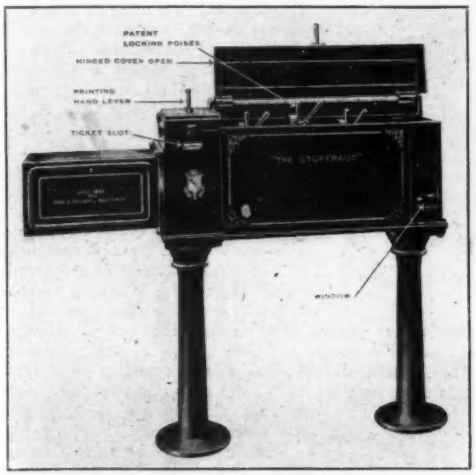
The annexed cut shows sectional illustrations of furnace ports after renewal by the process described, the work having been executed in from one to two hours.

Improved Weighing Apparatus.

A danger to the merchant who employs any weighing system in his business is carelessness, and occasionally fraud, on the part of the employé who attends to the weigher. The machine herewith illustrated is the latest designed by Messrs. W. & T. Avery, Limited, of Birmingham. It prevents either fraud or carelessness on the part of the weighman. The "Stopfraud" apparatus, as it is called, is designed to print the weight on a ticket, but the important point is that the ticket can be printed only if the weighman has obtained perfect equilibrium of the steelyard, or in other words, a ticket cannot be printed unless perfectly accurate balance has been achieved, thus providing irrefutable evidence in cases of dispute. If a weighman is not sufficiently enthusiastic in his employer's interest to remove surplus weight from the platform, the evidence of his carelessness goes upon record, and the merchant deals with the surplus delivery as he sees fit. Yet another advantage of the machine is that in cases where repetition weighings of, say, one hundredweight sacks or packages are to be delivered and checked out, the poises can be set at 1 cwt., the machine locked by means of a padlock, and any un-

trained employé told off to check out any number of packages; it being quite impossible for overweight lots to be sent out, since no ticket can be printed for weights that are even a fraction in excess of the specific variation which has been allowed in setting the machine.

When the hinged cover is open, the printing hand lever is locked, and the ticket slot closed. By moving the patent locking poises along a fixed bar the concealed poises are shifted until the steelyard is seen at the window to be in equilibrium. The hinged cover is then closed and the bolt handle must be drawn along to the right of the machine. This action, possible only when perfect balance is obtained, releases the printing hand lever, and opens



AVERY'S IMPROVED WEIGHING APPARATUS.

the ticket slot. But having weighed one package, the ticket slot is absolutely closed against the insertion of a fresh ticket, and remains so until the weighman has actually removed from the weighing platform the package for which he has obtained a ticket. If, however, the weighman, having lifted off that one package, returns the same load in preference to a new one, with the idea of getting through his work more expeditiously and with less trouble, the result will be 200 tickets bearing consecutive numbers, and each exhibiting precisely the same weight, say, 1 cwt. and one-fifth of a pound, and the lazy weighman's effort to shirk his work stands revealed.

This machine used in conjunction with a maintenance contract, it is claimed, offers merchants the greatest safeguard so far evolved. The makers, it may be mentioned, for the further convenience of their customers, station trained mechanics at their 150 branches and repair depôts throughout the British Isles.

A New Machine Vice.

The "NL" (no lift) machine vice (patented), of which the manufacturers are Messrs. J. Parkinson & Son, Shipley, Yorks, marks a distinct advance in machine-vice construction and one which we think will be generally appreciated by users of planing, shaping and similar machines, for which purposes the most desirable quality in a vice is that it shall hold fast and not "lift" or displace the work when the grip is applied. These results are obtained in the vice illustrated in a very simple manner, without the use of such expedients as retiring or pull-down jaws. The action of clamping the work, by exerting a downward pressure on the loose jaw, eliminates the possibility of lifting, whilst as the jaw plates are fixed, dirt and cuttings cannot get behind them. A further advantage is the swivelling action of the loose jaw which permits of tapered or irregular pieces being securely held.

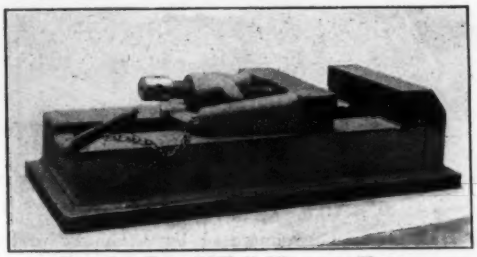


FIG. 3.—THE "NL" MACHINE VICE.

As will be seen on reference to our line illustration (Fig. 1), the construction is simple, with few parts, whilst if after continued usage the vices become worn, the original accuracy can be restored by replaning the upper and lower surfaces of the bed, so that both faces are parallel. The illustration clearly shows the method of construction and application. A is the base with fixed jaw and rack teeth B formed on the under side, C the loose jaw. The jaw plates D D are fixed by screws and are renewable. The dog nut E is provided with projections F and H, which engage with the rack teeth and rest upon the loose jaw respectively. The clamping screw, it will be seen, is threaded through the boss of the dog nut, and as the end of the nut which receives this screw is heavier than the end with the projection F, the tendency is for that end to fall and thus to bring the projection F into engagement with the rack, the projections H acting as the fulcrum.

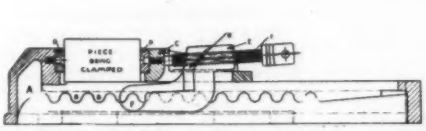


FIG. 1.—VICE IN CLAMPING POSITION.

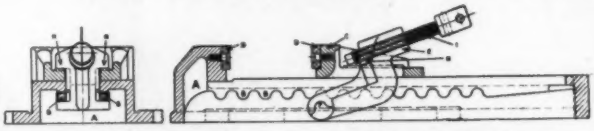


FIG. 2.—DOG NUT RAISED TO SLIDE LOOSE JAW.
THE "NL" MACHINE VICE.

The action of the vice calls for little explanation. To clamp a piece of work it is merely necessary to raise the screw sufficiently to disengage the projection from the rack and push up the loose jaw with the dog nut till suitable teeth are engaged; the screw is then wound home, the effect of which is a direct downward pressure on the projections H which rest upon the base of the loose jaw, so that increased pressure by the screw but serves to hold the jaw more firmly to the base.

D

Chipchase's Moulding Machine.

The accompanying illustrations show the operation of Chipchase's moulding machine, which is made by Messrs. David Bridge & Company, Limited, Manchester, and can be operated by either hydraulic, pneumatic or steam power. The hard and laborious part of the moulding operation is taken from the moulder, while the general design of the machine enables quick and accurate work to be executed. Underneath the table is arranged a steam, pneumatic or hydraulic cylinder, actuated by a special valve for raising and lowering the table on which is mounted the pattern and the moulding box. There is a stripping plate connected with the pattern. After the mould has been rammed, the table is turned over by special mechanism and brake which enables the moulding box to be parted from the mould and lowered on to a bogie by means of whichever operating power is used. The illustrations give a good idea as to how the machine works when making railway axle boxes. All kinds of repetition castings can be made on the machine.

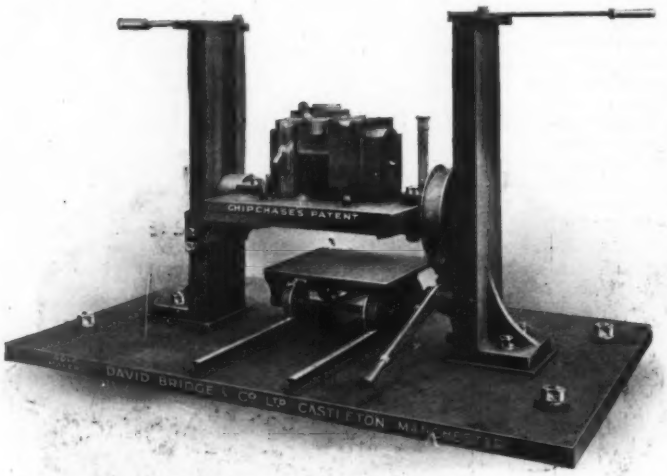


FIG. 1.—CHIPCHASE'S MOULDING MACHINE READY FOR MOULDING BOX.

In Fig. 1 the machine is shown with the pattern in position ready for receiving the moulding box. The bogey underneath is for removing the finished mould and box. The box is placed in position and the mould rammed by hand, as shown in Fig. 2, after which a covering plate is fixed on the bottom of the box. The table is then raised by the ram or piston of the machine, and turned with the box, until it reaches the position shown in Fig. 3, when it is ready for stripping the mould from the pattern. The stripping plate and mould are then lowered on to the bogey below (Fig. 4), at which point the plate is disconnected from the box and raised to its former place, after which the box is wheeled away, and the complete cycle of operations repeated. By this means all the box-lifting, turning and stripping is done mechanically, the moulder requiring only to ram the mould and operate the mechanism.

The machines are simple in design; there are no complicated parts to go wrong in operation. A great saving in the cost of patterns is claimed to be effected by this system, as there is only one required in consequence of being jointed at the top; the body of the mould being in the drag it is most practical to ram the top flask off a plate. Gaggers are dispensed with altogether.

FIG. 2.—POSITION OF TABLE WHEN MAKING MOULD.

CHANGE IN VOLUME AND SHAPE BY HARDENING STEEL.—The following conclusions relating to the changes which take place in the volume and shape of steel as the result of hardening are set forth in a treatise on the subject appearing in the "Zeitschrift" of the Vereines deutscher Ingenieure:—(1) The change in volume brought about by quenching steel is only small if the quenching temperature is within a limit close to the critical temperature. Very great changes in volume are brought about if this limit is even slightly exceeded. (2) Oil hardening gives smaller changes in volume than water hardening, but the difference is not very great. (3) Special additions, particularly nickel, bring about a decrease in the change of volume. (4) The greatest tendency to hardening cracks is shown by eutectoid steel, even greater than with steels of higher carbon that show greater change in volume.

Coke Dust Briquettes.

Our representative recently visited the works of Briquettes, Limited, Ross Street, West Gorton, Manchester, where an experimental plant has been put down for the manufacture of briquettes by the Faraday patent process. The plant was supplied by Messrs. Wm. Johnson & Son (Leeds), Limited, and is of their standard vertical type at 20 tons capacity, producing four rectangular bricks at each operation. The only material modification is the provision of a number of vertical rods disposed beneath and acting through the bottom of the mould, thus effecting the production of perforated bricks, which it is claimed ensure a better and more uniform burning effect. The special feature in the manufacture lies in the binding medium employed, which is the patent of Mr. Henry Faraday, neither tar, pitch, nor any form of oil being used. There is nothing elaborate in the process of manufacture of the coke briquettes. The coke dust brought in is screened, the rougher material being burnt under the boiler and the fine passing to the disintegrator, which, however, in this instance merely does duty as a mixer. The binder, in the form of a dry powder, is fed in by a worm conveyor; the mixture is then raised by a bucket elevator to the heater above the press, the necessary heat being imparted by the admission of steam. The bricks are then stacked into one of the two kilns, each of a capacity of 10,000 and worked alternate days. The temperature maintained in the kiln is about 300 deg. Fah. On leaving the kiln the bricks are hard and have a good surface. They are said to weather satisfactorily, and certainly they possess the peculiar property of hardening in the fire. Bricks of a glowing red in the furnace are not readily broken. The plant referred to is experimental, but run upon commercial lines, though many improvements in the layout naturally suggest themselves, not the least important of which would be the continuous kiln fed by a band conveyor direct from the press. It is interesting to note that the whole of the present output goes into local consumption.

FIG. 3.—MACHINE READY FOR STRIPPING MOULD FROM PATTERN.

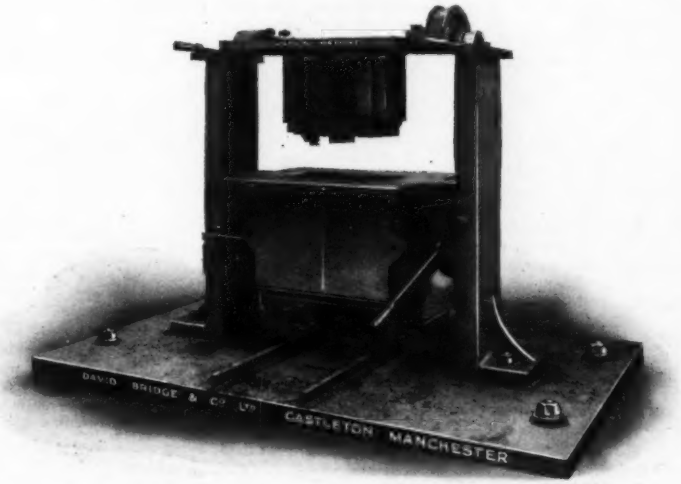


FIG. 4.—STRIPPING PLATE WITH BOX CLEAR OF PATTERN.

A NEW MANGANESE STEEL.—An improvement in manganese steel alloys is announced in a recent patent (U. S. 1,113,539—October 13, 1914) granted to W. Campbell, J. H. Hall and H. M. Howe. Commercial manganese steel contains from 11 to 14 per cent. of manganese, and hitherto any attempt to produce a steel lower in manganese than 10 to 11 per cent. has tended to make a metal nearly as brittle as glass and unfit for commercial use. The invention is based on the discovery, made by the inventors, that a certain critical relation exists between the percentage of manganese and the percentage of carbon employed with it in the alloy, and that by proportioning the carbon ingredients in accordance with this relation, a steel may be obtained containing from 6 to 9 per cent. of manganese or as low as 5 per cent., and "possessing to a very valuable degree the characteristic combination of ductility with hardness, and the other important properties of the richer alloys." It is believed that there is a practical limit, around 5 per cent., for the diminution of the manganese, according to the invention. The ingredients of the product are perfectly brought together in a molten state, as is usually the custom with manganese steel alloys. After casting, the metal is properly water-toughened.

Inventions.

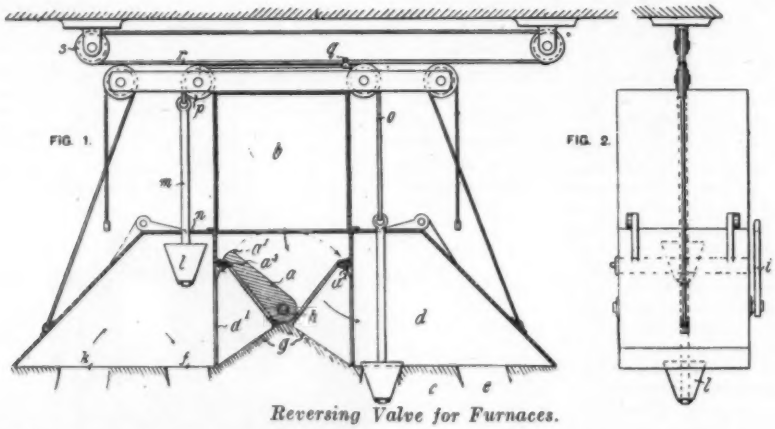
Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

8,680. Method of treating cores and moulds for casting and moulding phosphor bronze, molten metals, alloys, slag, etc., also for coating and lining vessels to contain molten metals, slag, etc., and for coating metal bodies so as to resist great heat. H. Levy.
8,889.*Case-hardening and other surface treatment of iron and steel articles. G. Stolle and A. Hocks.
8,956.*Castings. C. A. M. J. Delecroix.
8,991. Production of iron or steel. T. Rouse.
9,026. Chilled castings. J. H. Swift.
9,090. Shell-boring lathe. F. B. Waldron.
9,214. Regenerative furnaces. Drakes, Limited, and W. A. Drake.
9,475. Lathes or boring-machines. C. D. Andrew and F. W. Barraclough.
9,513. Production of metal castings in metal moulds. N. C. F. Jensen.
9,530. Furnaces for melting metals. I. Hall.
9,531. Boring or turning machines. M. T. Pickstone.
9,568. Furnaces. A. C. Ionides, jun.
9,659. Chucks for turning or boring lathes. R. Greenhalgh and J. Greenhalgh.
9,826.*Machines for cutting the teeth of worm, spur and spiral wheels. I. H. Wright and Smith, Major & Stevens, Limited.
10,771. Aluminium castings. J. D. Paton and T. Carbin.
10,964.*Power moulding-machine. A. S. Bixby.
11,125.*Moulding-machine. Harrison & Company, Limited, and A. W. Croxford.
11,131. Casting metals. W. B. Mair.
11,248. Apparatus for casting shells. B. D. Healey.
11,284. Furnaces. J. A. Hope.
11,294. Ingot moulds. J. H. Beckett.
11,343. Jib-cranes. S. H. Priestman.
11,366. Method of manufacturing shells. C. Bingham.
11,397. Production of uranium alloys. H. Bailey.
11,425. Shells and their manufacture. T. C. Smallwood.
11,436. Furnace bars. F. Prestwich.
11,453. Manufacture of grenades. A. Seeley.
11,530.*Firebridges for steam-generator furnaces. J. Pomeroy.
11,531. Making shells (ordnance). E. F. Smart.
11,594. Reverberatory furnace. C. Glossop.
11,765.*Chaplets for founding. J. Hall.

Abstracts of British Patent Specification Recently Accepted.

12,545 (1914). *Reversing Valves of Gas-fired Smelting Furnaces.* E. Lewis, 50, Manselton Road, Manselton, Swansea.—Fig. 1 is a diagrammatical sectional elevation, and Fig. 2 is an end elevation of a furnace top fitted with the valves. The main reversing flap valve *a* is rotatably mounted below the gas inlet and gas box in a casing or bonnet *b*, which is disposed above the furnace *c* and provided with side chambers *d* to allow the gas to enter the furnace *c* at one end *e* and to be drawn off



Reversing Valve for Furnaces.

to connect with the flue *f* in communication with the stack shaft at the other end or *vice-versa*. This reversing valve *a* is disposed in the middle of the divided casing *g* and is mounted on a shaft *h* at its lower end in the casing, in such a manner that when operated by a lever *i*, fitted externally of the casing, and preferably connected through links to a hand lever provided on a gantry or platform *j*, disposed above the furnace, the valve *a* is adapted to close either one or the other of the chambers *d*, and to put the other into communication with the gas supply. This reversing valve *a* is provided with a curved over lip or longitudinal projection a^1 on each side of its outer end, and this lip is adapted to lie, when the valve *a* is in its closed position in a tray a^2 containing sand. Each side chamber *d* is provided with an inlet or an outlet *k* to or from the furnace, and an outlet *f* to the stack shaft, but when the reversing valve *a* is in a position to allow the gas to communicate through one of the chambers *d* to one side *e* of the furnace *c*, the outlet *f* from this chamber to the stack must be closed and the outlet *f*

9,952. Manufacture of chromium and iron compounds. T. J. I. Craig and P. Spence & Sons, Limited.
9,990. Core-making machines for foundry purposes. J. J. Warren and W. Valentine.
10,101.*Method of casting ingots, and particularly steel ingots. T. D. Kennedy.
10,117. Tungsten. J. C. Butterfield.
10,281. Combined apparatus for melting and casting metal. I. Hall.
10,340. Process and apparatus for casting hot metal in ingot, etc., moulds. E. Whitnear.
10,355. Apparatus for turning metal blanks. E. Hamilton and J. Hamilton & Sons, Limited.
10,376. Grinding machines. Willans & Robinson, Limited, and F. W. Shaw.
10,440. Metal-moulding frame. F. J. Corfe.
10,594. Moulds for casting purposes. A. Gybbon-Spilsbury.
10,601. Annealing furnaces. W. D. Williams.
10,635. Separation and extraction of dust and iron from brass borings, brass turnings, etc. W. Sowden.

to the stack in the other side chamber *d* opened. The valves *l* are weighted and hung on rods *m* which pass through holes *n* in the casing *d*, and are connected to each other by a chain *o* which is adapted to pass over pulleys *p* mounted above the casing so that when one valve *l* is open the other is closed. This chain *o* is adapted to be linked by a suitable connection *q* to an endless chain *r* passing over pulleys *s* hung from the platform *j*, and is adapted to be operated by a hand-wheel on the platform through any suitable gear.

Personal.

THE late Mr. Edgar Havelock Claye, a director of S. J. Claye, Limited, railway rolling stock manufacturers, left £39,537.

THE late Mr. John Alexander MacLellan, director of Allen & MacLellan, engineers and shipbuilders, Glasgow, left estate valued at £14,079.

THE late Mr. Samuel Tyzack, of Barwythe, Studham, near Dunstable, colliery owner and ironfounders, left estate of the gross value of £160,341.

THE gross value of the estate of the late Mr. C. E. P. D. Spagnoletti, late chief electrical engineer to the Great Western Railway Company, is £35,070.

SIR AMHERST SELBY-BIGGE has been appointed special secretary to the Committee of the Privy Council for the organisation and development of scientific and industrial research.

MR. N. HEINZ has been appointed consulting engineer in connection with the erection of the large new spelter plant which the American Steel and Wire Company are erecting at Donora, Pennsylvania.

MR. PERCY WOODS, the organising secretary of the new munitions area for South Wales and Monmouthshire, and also for the South-West of England, has taken up his position with his staff at Newport.

MAJOR-GENERAL SIR PERCY GIROUARD has been re-elected a director, and Colonel A. G. Hadcock and Lord Sydenham have been elected directors, of Sir W. G. Armstrong, Whitworth & Company, Limited.

MR. A. C. JONES, of The Mount, Winterbourne, Gloucestershire, chairman of the Uskside Engineering Company and a director of Partridge, Jones and Company, Limited, who died on May 27, aged 73 years, left £73,980.

MR. F. W. HARBORD, consulting metallurgist, of 16, Victoria Street, London, S.W., has been appointed Honorary Advisor in Metallurgy to the Munitions Committee, and is now devoting his whole time in that capacity at Armaments Building, Whitehall, S.W.

THE late Mr. T. A. Bayliss, J.P., of St. John's, Warwick, chairman and joint managing director of the King's Norton Metal Company, Limited, a director of the Sharpness New Docks, and Gloucester and Birmingham Navigation Company, Limited, left estate valued at £48,453.

THE DUKE OF DEVONSHIRE, having been appointed a Civil Lord of the Admiralty, has resigned his several directorships, including the chairmanship of the Furness Railway Company. The Duke is succeeded by Lord Muncaster, deputy-chairman of the Company, and Mr. Myles Kennedy has been elected a director.

THE RIGHT HON. SIR DAVID HARRELL, K.C.B., has been appointed a member of the Committee on Production in Engineering and Shipbuilding Establishments, and to act in the place of any of the present members of the Committee (Sir George Askwith, Sir Francis Hopwood, and Sir George Gibb) who may have to be absent.

MR. W. H. ELLIS, one of the directors of John Brown & Company, who has held the office of Master Cutler for the past twelve months, was re-elected for the ensuing year at Sheffield last month. Mr. Albert Senior was elected a member of the Cutlers' Company to fill the vacancy caused by the death of his father, Alderman George Senior.

MR. WM. BURTON, who has retired from the position of manager and director of the Pilkington Tile and Pottery Company, Clifton, near Manchester, which is allied with the Clifton and Kearsley Coal Company, has been presented by the employés with an illuminated address and a silver bowl. Mr. Burton had been connected with the firm for nearly a quarter of a century.

THE following members of the West of Scotland Iron and Steel Institute are serving with H.M. forces:—Sydney A. Beard, trooper, 4th Scottish Horse; Peter Braidwood, trooper, 2/2nd Scottish Horse; David Colville, jun., Lieut., Fife and Forfar Yeomanry; William Cunningham, Sergt., 8th H.L.I.; Leopold G. Fawcett, Lieut., Lanarkshire Yeomanry; John Hamilton, Sergt. 17th Service Batt. H.L.I. (3rd Glasgow); P. D. Ionides, Captain, 16th Batt. Middlesex Regiment; L. R. G. Jenkins, private, 5th Batt. Queen's Own (Lochiel's) Cameron Highlanders; J. L. C. Jenkins, private, 5th Batt. Queen's Own (Lochiel's) Cameron Highlanders; J. Lusk, Staff Captain, Scottish Rifle Brigade; Thomas B. McNamee, R.A.M.C., E. Company, Aldershot; Edgar W. Rogerson, Lowland Division Royal Engineers; R. McAra Steele, Lieut., 8th Batt. (The Argyleshires) Princess Louise A. and S. H.; Robert Stewart, 5th Batt. Queen's Own (Lochiel's) Cameron Highlanders; V. B. Stewart, Lieut., 5th H.L.I.; C. A. Valentine, Captain, The Cumberland Artillery; W. N. Watson, 3rd Batt. H.L.I.; E. J. Whitson, Second-Lieut., 2/9th H.L.I. (Glasgow Highlanders). Second-Lieut. Thomas Hervey Hathaway, 2nd King's Own (Royal Lancashire Regiment) and Captain A. J. Martin, 9th H.L.I. (Glasgow Highlanders) have been killed in action.

Steel Export Licences.

The Admiralty, in order to facilitate business and to expedite the granting of certificates for the export of steel and articles manufactured therefrom, invited the Glasgow Chamber of Commerce to set up a Committee to deal with the issue of licences for the export of these articles. The Chamber of Commerce nominated the following gentlemen, viz.:—Mr. Montague M. W. Baird, president; Mr. James W. Murray, vice-president; Mr. W. J. Chrystal, John and James White, chemical manufacturers, Glasgow; Mr. Archibald Colville, David Colville & Sons, Limited, Dalzell Steel and Iron Works, Motherwell; Mr. James M'Skimming, Steel Company of Scotland, Limited, Glasgow; Mr. T. O. Mathieson, Alex. Mathieson & Sons, Limited, tool makers, Glasgow; and Mr. George A. Mitchell, Stewarts & Lloyds, Limited, steel manufacturers, Glasgow.

The Admiralty approved, and the Committee has been constituted. The existing limits of free exportation of steel are that it contains no tungsten or molybdenum. If it contains either of these metals, the exporter must obtain a licence from the War Trade Department before it can be shipped. If it does not contain any of the prohibited metals, it can be shipped on the certificates issued by the Chamber of Commerce Committee. The area to be dealt with by the Glasgow Committee embraces the whole of Scotland.

The Newcastle Chamber of Commerce have, in response to an invitation from the Admiralty, also set up a committee to deal with the issue of licences for the export of steel. The following have been appointed to act as the committee of the Chamber of Commerce for this purpose:—Mr. Henry Peile, of the Newcastle Alloy Company; Dr. J. T. Dunn, analytical chemist; Mr. J. R. Lynas (John Spencer & Sons, Limited); Mr. A. Sopwith (Palmers' Shipbuilding and Iron Company, Limited); Mr. L. Ennis (Dorman, Long & Company, Limited); and Mr. Herbert Shaw, hon. secretary. Mr. Henry Peile has been elected chairman of the committee. A letter has been received from the Admiralty indicating the work of the committee: the fees to be charged for the certificates according to the value of the steel exported, and the area of the committee's authority, this being northwards to the borders of Scotland of a line drawn from Lancaster to Scarborough.

Trade Talk.

THE WEARDALE STEEL, COAL AND COKE COMPANY, LIMITED, have blown out a furnace on hematite.

THE PIRELLI GENERAL CABLE WORKS COMPANY, LIMITED, have just completed their new factory at Southampton.

A WINDING-UP ORDER has been made in connection with the affairs of the Lancashire Brass Founders, Limited, Blackburn.

THE liquidators in the winding-up of the English McKenna Process Company, Limited, Birkenhead, have been released.

A FIRST and final dividend is notified in connection with the affairs of Joseph Phillips & Company, 68, Elcho Street, Glasgow, metal merchants.

MR. R. THOMAS, iron founder, carrying on business as J. and R. Thomas, the Foundry, Llanrwst, Denbighshire, has been adjudicated bankrupt.

THE CARDEN ENGINEERING COMPANY, LIMITED, is in voluntary liquidation, with Mr. A. R. K. Farlow, 50, Gresham Street, London, E.C., as liquidator.

THE engineering concern of John Baker, Limited, Wisbech, is to be wound up, and Mr. W. J. Adnitt, Oriel House, Peterborough, has been appointed liquidator.

THE CONSOLIDATED DIESEL ENGINE MANUFACTURERS, LIMITED, of General Buildings, Aldwych, London, W.C., are paying a first and final dividend of 20s. in the £.

AN order has been promulgated by the Board of Control restricting the hours for the sale of exciseable liquors in the eastern and western areas of Scotland.

IN connection with the affairs of the Wooler Engineering Company, Limited, London, N.W., Mr. J. F. Hull, Gringley, Uphill Road, Mill Hill, has been appointed receiver.

MESSRS. DOBBIE, FORBES & COMPANY, ironfounders, have transferred the business formerly carried on at Hecla Foundry, Glasgow, to their Larbert Stove and Ironworks, Larbert.

MESSRS. ARMSTRONG, WHITWORTH & COMPANY, LIMITED, are adding a three-ton Héroult electric steel furnace to their new Canadian plant at Longueil, near Montreal.

A FINE motor ambulance, provided by the Sheffield employés of Vickers, Limited, has been handed over to the Red Cross Society, together with a cheque for £100 towards its upkeep.

MESSRS. B. PRESTON and C. B. YOUNG, carrying on business as machine makers, at Batley, under the style of Benjamin Preston & Sons, have dissolved partnership. Mr. Preston continues.

THE public examination of Mr. R. Thomas, ironfounder, carrying on business as J. & R. Thomas, Llanrwst, Denbigh, has been fixed for September 14, at the Court House, Blaenau Festiniog.

THE COMMONWEALTH GOVERNMENT has decided to open the proposed Metal Exchange at Melbourne on September 6, after which date all transactions will have to be conducted through this Exchange.

MESSRS. CURRAN BROS., furnace builders, have transferred their offices from 72, Bute Street, Cardiff, to the newly-erected premises adjoining their engineering works, Hurman Street, Clarence Bridge, Cardiff.

THE business of Messrs. James M'Namee and Sons, iron merchants, Wishaw, carried on by Rosina Gibson or M'Nameé, Richmond Place, Wishaw, has been transferred to Mr. George M'Namee, of Richmond Place, Wishaw.

THE business of J. and R. Hogarth, engineers and millwrights, Kelso, has been taken over by Mr. G. Cloy, Mr. J. Fairgrieve and Mr. A. Walker, all of whom have been in the firm's employment for a considerable number of years.

THE NATIONAL ADVISORY COMMITTEE ON WAR OUTPUT have issued a manifesto to workers in the engineering and allied trades, in which they declare that a restriction of output in this great crisis cannot be too emphatically condemned.

THE shareholders of the Middlesex Foundry and Metal Company, Limited, will meet at Finsbury Court, Finsbury Pavement, London, E.C., on September 7, for the purpose of considering the liquidator's report of the winding-up of the Company.

THE partnership heretofore subsisting between Messrs. A. T. Pugh and G. C. Ilett, carrying on business as engineers and metal workers, at Winchelsea Works, Hesketh Road, Forest Gate, Essex, under the style of Arthur & Company, has been dissolved.

MESSRS. GUEST, KEEN AND NETTLEFOLDS, LIMITED, are making considerable extensions at their London Works, Smethwick. Nearly 4,000 of the Company's employés have joined the colours during the war, and substantial allowances have been made to their dependents.

THE estates of R. Anderson & Company, metal merchants, Jane Street, Leith (of which D. W. Kemp and C. Cooper are the sole partners), have been sequestrated by the Sheriff of the Lothians and Peebles at Edinburgh. A meeting of the creditors was held on August 20.

OWING to the changes brought about by the war, the British Mining and Metal Company, Limited, 123/127, Cannon Street, London, E.C., are extending the manufactures of their Greenhill Works, Gunnislake, Tavistock, and have decided to transfer their registered offices to that address.

MR. A. S. MACHARG, 115, St. Vincent Street, Glasgow, the trustee of the sequestrated estates of Joseph Philips & Company, metal merchants, 68, Elcho Street, Glasgow, and John Walker Fullarton, the sole partner, intimates that a first and final dividend will be paid on and after September 4.

THE average price of Scotch pig-iron warrants during July, as ascertained by Messrs. Wm. Jacks & Company, was 73s. 0½d., which compares with 72s. 4½d. in June, 70s. 11½d. in May, 72s. 8¾d. in April, 67s. 0¾d. in March, 62s. 6d. in February, and 62s. in January. The average price for July, 1914, was 57s. 3½d.

A PETITION has been presented to the Sheriff of the Lothians and Peebles at Edinburgh at the instance of Walkers, Parker & Company, Limited, for sequestration of the estates of R. Anderson & Company, metal merchants, etc., James Street, Leith, and D. W. Kemp and C. Cooper, the individual partners.

THE firm of Barclay, Ross & Tough, engineers, etc., Aberdeen, has been dissolved by the retirement of Mr. R. Tough. The business will be continued by the remaining partners, Mr. R. Robertson Ross and Mr. T. Hutchison. Mr. R. Tough has established himself in business at Imperial Place, Aberdeen, under the style of R. Tough & Sons.

MESSRS. WM. JACKS & COMPANY, of Glasgow, have ascertained that the average price of Middlesbrough pig-iron warrants during July was 67s. 0½d., as against 66s. 7½d. for June, 64s. 9d. for May, 66s. 7d. for April, 61s. 8¾d. for March, 56s. 5½d. for February, and 56s. 2d. for January. In the corresponding month of last year the average price was 51s. 3½d.

THE partnership heretofore subsisting between Messrs. F. R. Swinburne, senior, and F. R. Swinburne, junior, carrying on business at 7 and 9, Pershore Street, Birmingham, as brass factors, under the style of Swinburne & Son, has been dissolved. The business will in future be carried on by Mr. F. R. Swinburne, senior, in his own name, at 5, Pershore Street, Birmingham.

THE TYNESIDE ALLOYS COMPANY, LIMITED, of Pelaw, Newcastle-on-Tyne, which is engaged in the manufacture of tungsten and molybdenum powders, is open to purchase and treat all kinds of stanniferous tungsten ores and leady bismuth-molybdenum ores. The plant is under the management of Mr. William Jones, who formerly represented Mr. John Hays Hammond in Brazil.

THE SWANSEA VALE SPELTER COMPANY, LIMITED, of the Swansea Vale Spelter Works, Llansamlet, are

acquiring twelve more acres of land on the Morriston Marshes, on which it is contemplated erecting additional furnaces. It is now stated that a group of financiers, headed by Mr. R. Tilden Smith, who is interested in the zinc mines of Burma, has obtained an option with a view to developing the operations in Wales on a large scale.

THE partnership heretofore subsisting between Albert Newbould and John Hopkinson, carrying on the business of cutlery manufacturers, under the styles of J. & F. Hopkinson & Company, and the Penton Cutlery Company, at Penton Works, Penton Street, Sheffield, has been dissolved by mutual consent. Albert Newbould will carry on the business under the style of the Penton Cutlery Company.

MR. REGINALD LE NEVE FOSTER has presented the Royal Society of Arts with a donation of £140 for the purpose of founding a prize in commemoration of his father, Mr. Peter Le Neve Foster, who was secretary of the Society from 1853 to 1879. The council have determined to offer the prize for a paper on "Zinc, its Production and Industrial Applications." The prize will consist of a sum of £10 and the Society's silver medal.

A FIRE occurred on August 1 at the works of the Ebbw Vale Steel, Iron and Coal Company, Limited. The first intimation of the outbreak was made in the early afternoon, when a report was circulated that the generating station near the Victoria blast furnaces had caught fire. Shortly afterwards the fire had gained such a hold on the building that it was found necessary to summon the fire brigade. The flames rapidly spread to the power house and the engine house. The generating and power houses were gutted, and the engine house seriously damaged.

MESSRS. BAXTER, FELL & COMPANY, of 22-23, Great Tower Street, London, E.C., have established themselves in business as iron, steel, metal and hardware agents and merchants. The partners in the firm are Mr. F. Baxter, Mr. P. H. Fell, and Mr. R. Wery. The company hold the following agencies:—R. Wery, Charleroi; Jacques Lecomte & Fils, Havre; Carl Lunds Fabriker A/S, Copenhagen; Laminoirs de l'Alliance, Charleroi; and R. H. Middleton & Company, Sheffield.

MESSRS. ROBERT HAMMOND & SON, engineers, of 64, Victoria Street, Westminster, S.W., referring to the death of their senior partner, Mr. Robert Hammond, which we announce on page 506, state that it is the intention of the firm to carry on the practice under the old name and at the same address. Pending the return to civil life of the junior partner, Captain R. W. Hammond, now on active service, Messrs. Preece, Cardew, Snell & Rider have undertaken to execute, on behalf of the firm, all work now in hand, and any future work which may be entrusted to it.

GLASGOW DEAN OF GUILD COURT, on August 12 granted warrants to Messrs. Alexander Stephen and Sons, Limited, engineers, etc., Linthouse, to erect a steel-framed building for a store; to Messrs. William Beardmore & Company, Limited, to erect a hammer forge in Duke Street, a pay office in East Wellington Street, and a drawing office and extension of motor-garage in Old Edinburgh Road, Parkhead, to Messrs. G. and J. Weir, Limited, engineers, Cathcart, to erect extensions, and to Messrs. Barr and Stroud, Limited, engineers, Anniesland, for alterations and additions.

LORD D'ABERNON, chairman of the Central Control Board (Liquor Traffic), has opened at Avonmouth a canteen which will enable workers to obtain foods and non-alcoholic liquors at low prices. In the course of a speech made in connection with the opening, he said it had not yet been sufficiently realised that when they asked men working at the docks or on munitions for high efficiency it was essential to give them good refreshments and good food. Provision of facilities in this direction was not only an indispensable condition to obtaining the full output of which a man was capable, but it was also at the root of a great many of the difficulties by which legislators had been confronted in the management of the drink traffic.

MEETINGS of the creditors of the Renishaw Iron Company, Limited, and Appleby & Company, Limited, ironfounders, Renishaw, which concerns are in voluntary liquidation, were held last month. A statement was submitted indicating that subject to realisation the estate showed a surplus over liabilities. The failure of the companies was attributable to the war which, whilst benefiting the steel trade, had operated greatly to the disadvantage of the classes of iron made at Renishaw, with the result that it had been impossible to cover the heavy increases in the costs of production. The meeting was adjourned to enable the managing director to confer with the debenture holders with reference to the sale of the concerns in the best interests of the creditors.

THE GLASGOW AND WEST OF SCOTLAND ARMAMENTS COMMITTEE is to be discontinued as a separate body. At a meeting of the Committee, last month, the Lord Provost reported that he had received a letter from Mr. Lloyd George referring to the local organisation of the Ministry of Munitions which was being set up in various parts of the country, stating that it was proposed for the West of Scotland to appoint a Board of Management, consisting of not more than five engineering employers, with a Labour Advisory Board with not more than seven representatives of labour, and that when these steps had been taken it would no longer be necessary to continue the activities of the present Armaments Committee otherwise than as a Consultative Committee. Under these circumstances, the Committee was unanimously of opinion that no useful purpose would be served by its continued existence as a separate body.

SPECIAL alloys have attained positions of high importance in the preparation of metals for the heavy arts, more especially of steels and bronzes. Until recently the manufacture of these alloys was carried out mainly on the Continent. The firm of Kent Smith, Limited, Bank Chambers, Fargate, Sheffield, have established a factory for their production in Sheffield, thus creating a new industry in that city. The products of their works comprise carbonless alloys (ferrous and non-ferrous) of many descriptions, including metallic manganese, cupro manganese, ferro titanium, ferro-vanadio titanium, metallic chromium, and ferro-chrome. Preparations for the manufacture of other alloys are being pushed forward. The technical conduct of the Company's operations is under the continuous personal supervision of Mr. J. Kent Smith, a metallurgist and technologist of long experience, whose name is perhaps best known in connection with commercial vanadium and with the inception and development of the vanadium steels, which latter have come into much prominence in the last decade.

WHEN a deputation from the council of the Society of Chemical Industry waited recently on the Minister of Munitions and offered the services of the society to the Government in the present national crisis, the minister asked whether a classified list of members of the society was in existence, as it might afford some idea of the possible chemical resources of the empire. In reply, the deputation admitted that the present classification of the society was not precise enough for the purposes of H.M. Government, and promised to supply a more perfect one. The council accordingly are inviting all members to supply the necessary particulars for a new classification. Dr. Addison inquired whether the present organisation of the society was such as would enable it:—(a) To furnish at short notice, at request, a reliable and complete statement as to the possible sources of supply of particular chemical products; (b) to keep the Government informed from the manufacturers' point of view of difficulties arising from time to time as respects labour, materials, transport and so forth which may be interfering seriously with the output of essential chemical products.

MESSRS. CAMMELL, LAIRD & COMPANY, LIMITED, of Sheffield, have agreed to act for the Government in

the erection and management of the national engineering factory at Nottingham. The factory, which is one of the several that are being established throughout the country, will employ about 4,000 men. It will be erected by Sir William Arrol & Company on a site of some twelve or thirteen acres, at the end of King's Meadow Road, which the Corporation of Nottingham are leasing and placing at the disposal of the Government. The site adjoins the Midland main line, so that ample railway sidings can be obtained for the delivery of raw material and the despatch of finished goods. The driving power is to be electricity, the Corporation of Nottingham intending to erect a special electrical station on the spot to supply the works. The Nottingham City Council has unanimously endorsed the proposal of the General Purposes Committee to lease about 12 acres of land at an annual rental of £300 and to "place the site for the duration of the war and six months afterwards at the disposal of His Majesty's Government, the Government to have the option of purchasing the site on terms agreed with the owners at any time during that period."

At the annual meeting of the British Association for the Advancement of Science, at Manchester, from September 7 to 11 next, the Engineering Section (G) is to be presided over by Dr. H. S. Hele-Shaw, F.R.S. This section will include a report of the Committee on "Complex Stresses." Professors G. Asakawa and J. E. Petavel are contributing a paper dealing with an "Experimental investigation of the thermal efficiency of a gas-engine," an allied contribution being that by Professor W. M. Thornton on the "Apparent specific heats in gaseous explosions." Electrical papers are contributed by Professor Miles Walker, Dr. W. Eccles, and Mr. A. J. Makower, wireless telegraphy being represented by Professor G. W. O. Howe. "The strength of iron, steel, and cast-iron struts" is the subject of a paper by Mr. Andrew Robertson, whilst Professor Ernest Wilson contributes a metallurgical paper dealing with "Exposure tests on some metals and alloys."

A meeting was held at Workington on August 3 for the purpose of electing a representative committee to consider how the resources of the county could be best utilised and to submit a scheme to the ministry for the production of munitions. The meeting was convened by the Mayors of Workington and Whitehaven, at the request of the Lord Lieutenant of the county. The Mayor of Workington (Alderman P. Walls) presided over a large gathering representative of all the interests concerned. The Town Clerk of Workington read a letter from the Minister of Munitions, instructing the meeting as to the constitution of the committee and its duties. On the motion of Sir J. Randles, M.P., it was agreed that the committee should consist of 27 members, equally representative of the employers, employed, and the municipal and urban authorities in the West Cumberland area. The following were appointed to form a committee:—Employers: Sir J. S. Randles, M.P. (steel), Messrs. G. T. Marley (iron), L. T. Helder (iron-ore), L. H. Fletcher (coal), J. Milburn (engineers), J. A. Haynes (transport), W. Burnyeat (limestone), J. Ellis (ferro-manganese), W. J. D. Burnyeat (coke, benzol and other products). Employed: Messrs. J. Flood, J. Cassidy, J. Carruthers, T. Cape, T. G. Duffy (Cleator Moor), W. Carlton, A. J. Gibbs, W. Cowen (Whitehaven), and L. S. W. Sanham. Municipal and urban authorities: The Mayors of Whitehaven and Workington and the chairmen of the Cockermouth, Maryport, Harrington Cleator Moor, Arlecdon and Frizington, Egremont and Millom Urban District Councils.

It is officially announced that up to August 18 535 establishments had been declared "controlled establishments" under Section 4 of the Munitions of War Act, 1915. "As a result of this control," continues the announcement, "the profits of the employers are limited, and the Act provides that any excess profit over such limit shall be paid into the national Exchequer. By this provision Parliament has secured that the sacrifice made by the workmen are made for the nation as a whole and not for the benefit of individuals. On the other hand, during the period of the war any rules or shop customs which may have the effect of limiting the output of munitions are suspended in controlled establishments. Guarantees are provided by the Act to protect wages and conditions of employment, and to secure that such suspension of rules and shop customs shall be strictly limited in time and shall in no way prejudice the position with regard to such rules and customs after the conclusion of the war. Munition tribunals are set up under the Act to secure the enforcement of the rules made for efficiency and order in controlled establishments. The result of these provisions is to secure that the combined efforts of employers and employed may be devoted to the one end of providing the British forces with an ample supply of munitions to enable them to defeat the enemy. Steps have been taken to supply notices to be posted in all controlled establishments informing the employés that such establishments are in fact controlled. No list, however, has been published, since the naval and military authorities consider it undesirable to publish in a collected form the names and addresses of the controlled establishments, all of which are engaged on munition work."

In a recent issue we published some information, supplied by an anonymous correspondent, regarding the shipments of pig-iron from Middlesbrough to Scandinavian ports, and our comment at the time was that, so far as the shipments to Norway were concerned, no doubt a considerable quantity of the pig-iron was destined for Russian consumption. Our correspondent apparently takes exception to that explanation, inasmuch as in a further communication he points to the lack of railway facilities between Norway and Russia. In this second statement the correspondent writes:—"Below are some statistics regarding the shipments of pig-iron from Middlesbrough to Norway, Sweden and Denmark:— Total shipments January 1 to end of July, 1914, 68,735 tons; total shipments January 1 to July 26, 1915, 66,096 tons; shipments January 1 to end of May, 1914, 50,252 tons; shipments January 1 to end of May, 1915, 18,081 tons; shipments June 1 to end of July, 1914, 18,483 tons; shipments June 1 to July 26, 1915, 47,925 tons. It will be noticed that in spite of the war the shipments for the first seven months of 1915 practically equal those of 1914. In spite of great falling off in shipments during the first five months of 1915 the deficit has been made up between June 5 and July 26 inclusive. Of necessity a great portion of the deficit of shipments during the first five months of this year is lost and gone for ever. The enormous June and July shipments cannot be taken as filling up the gap. The suggestion that portions of the shipments to Norwegian ports have Russia for their final destination cannot be accepted, as the connection between the two countries consists of nothing more substantial than reindeer sleds, and one can only conclude that the local Licensing Committee in Middlesbrough is being hocussed with regard to the real destination of much of the iron that has been, and is being, shipped, and the painful part of it is, that at any rate a large proportion of the people doing this business must be well aware that, if they are not trading with the enemy, they are being made the means of supplying German Baltic Ports with what it requires in foundry iron." The comment alluded to drew attention to the possibility of some of the pig-iron shipped to Norway going to Russia. Although no through railway communication exists, the distance between the Swedish and Finnish railway termini is covered by road transport. Whether or not it would be worth while to send pig-iron this way we cannot say, but the point is easily capable of investigation and proof by the Russian authorities.

COMPLETE

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JAMES EVANS & Co. BRITANNIA WORKS, BLACKFRIARS. MANCHESTER.

Deaths.

Mr. Robert Sharp, retired iron merchant, Coatbridge, died suddenly at Rothesay on August 4, aged 79 years.

The death is announced of Mr. Robert Russell, a well-known Tees-side iron merchant. Mr. Russell took no active part in public life, but he was a familiar figure on 'Change at Middlesbrough.

Sec.-Lieut. Miller, of the North Lancashire Regiment, is reported to have been killed in action on the 27th ult. He was the eldest son of Mr. T. Miller, manager of the Wolsingham Steelworks of John Rogerson & Company, Limited.

Mr. David Reece, who died at Workington last month, was for many years identified with the iron and steel industry at Workington. He was manager of the Moss Bay Iron and Steel Works at Workington for 27 years, and retired from the position about 10 years ago. The deceased was in his 71st year.

The death is announced of Mr. Herbert Biggin, of Mayfield Road, Ashbourne. The deceased, who was in his 64th year, was a native of North Derbyshire, but for many years had resided at Ashbourne, and held the post of manager of the Derbyshire Silica Firebrick Company, at Parsley Hay.

Mr. John Barr, managing director of Glenfield and Kennedy, Limited, hydraulic engineers, Kilmarnock, died on August 12, aged 60 years. The deceased entered the office of the Glenfield Works as a lad, and rose to be secretary of the company, latterly filling the position of managing director.

The death is announced from the Dardanelles of Captain Lionel G. O. Townsend, 7th South Staffordshire Regiment, only son of Mr. O. C. Townsend, secretary and general manager of Messrs. Hill & Smith, Limited, Brierley Hill Ironworks, Staffordshire. Captain Townsend was an electrical engineer, but a couple of years before the war he was appointed to assist in the management of the works of Messrs. Hill & Smith, Limited.

We regret to announce the death of Mr. Alfred Bowen at his residence, Cardiff, on the 10th ult. Born at Brecon, he was taken in childhood to Dowlais, where he subsequently passed into the Dowlais Works. He became manager under the late Mr. E. P. Martin, and after a lapse of five years, when he held the post of manager of the Darlington Steel and Iron Company, Limited, he was asked to return to Dowlais as manager, which position he held until his retirement some years ago.

The death is announced of Sir John Storey Barwick, Bart., a well-known captain of industry on the North-East Coast, at the age of 75. He was a native of Sunderland and commenced his business career in a humble position in the office of the Ryhope Coal Company, Limited, Sunderland. Among the companies with which he was prominently associated were the Weardale Steel, Coal, and Coke Company, the Cargo Fleet Ironworks, as well as many others. On various commercial bodies of Sunderland and district Sir John rendered valuable service. He was also one of the local directors of Lloyd's British Testing Company. His baronetcy was conferred upon him on New Year's Day, 1912. The title will descend to his eldest son, Mr. John S. Barwick.

Mr. Robert Hammond, one of the pioneers of the electrical industry, has died at the age of 65 years. The deceased gentleman took up electrical problems towards the end of the seventies in connection with the engineering business which he had at Middlesbrough. He developed the incandescent lamp, and laid down the first central lighting stations in this country, namely, those at Brighton, Eastbourne, and Hastings. In addition he acted as consulting engineer for many electricity supply undertakings, and he laid down several supply works in the United Kingdom and abroad. He founded in 1884 the Hammond Electrical Engineering College, and in 1890 the Electrical Standardising, Testing, and Training Institution.

The death occurred on Sunday of Mr. Joseph Ash, at his residence "Galveston," Leamington, in his ninety-second year. The son of Mr. Thomas Ash, he was educated at King Edward's School, Gem Street, and at an early age entered the zinc business which his father had established in Birmingham. He acquired a sound practical knowledge of the zinc trade, and helped materially to build up its fortunes, undertaking large contracts for zinc work for railway companies. At the age of 33 Mr. Joseph Ash commenced business on his own account in Meriden Street, Birmingham, where he carried on the zinc trade, following up the extensions of railway operations by preparing to meet the demands which arose for a variety of railway stores of the hardware kind. In 1864 he was joined in partnership by the late Mr. J. P. Lacy, and this extension resulted in developments in the Meriden Street business, where all kinds of copper and zinc goods were manufactured. In 1896 the concern was converted into a private company, under the style of Ash & Lacy, Limited.

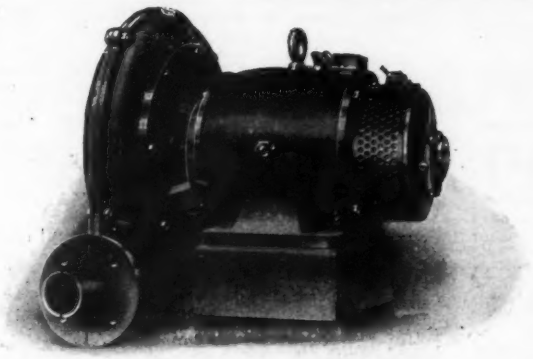
We regret to announce the death of Mr. Henry Steel, one of the founders of the firm of Steel, Peech & Tozer, Limited, the Ickles, Rotherham, which occurred on Tuesday, at his residence, Tapton Court, Fulwood Road, Sheffield, in his 84th year. The business career of the deceased gentleman was singular, inasmuch as it was divided between sport and commerce, the turf providing him in early life with the opportunity of laying the foundation of his subsequent prosperity. In 1874 Mr. Steel branched off into commercial pursuits. In that year the works of the Phœnix Bessemer Steel Company came into the market. Mr. Steel came forward with Mr. Peech, Mr. E. Toxer, and Mr. Hampton, purchased the works for £36,500, giving an additional £10,000 for the loose tools and plant. The concern having been turned into a private limited company with a capital of £70,000, it was carried on under the style of Steel, Tozer, and Hampton, Limited. After a few years Mr. Hampton ceased his connection with the business, and the name of the firm was altered to Steel, Peech, and Tozer, Limited, the title which it has since retained.

Munitions Inventions.

The Minister of Munitions has constituted a Munitions Inventions Branch of the Ministry and has appointed as Comptroller Mr. E. W. Moir, M.Inst.C.E. and M.Am.Soc.C.E. The Branch, which for the present is located in Armament Buildings, Whitehall Place, London, S. W., will have the duty of considering projects for inventions relating to munitions for warfare on land, or matters appertaining thereto. The Comptroller and staff of the Branch will be assisted in their work of examination, and, if thought necessary, in the investigation and development of any projects that may be considered worthy of being developed, by a panel of honorary scientific and other experts.

The following gentlemen have accepted Mr. Lloyd George's invitation to act on this panel:—Colonel Goold Adams, Mr. Horace Darwin, F.R.S., Mr. Macdougal Duckham, Mr. W. Duddell, F.R.S., Mr. Z. de Ferranti, D.Sc., Professor Glazebrook, F.R.S., Sir Robert Hadfield, F.R.S., Professor J. S. Haldane, F.R.S., Colonel N. B. Heffernan, Sir Alexander Kennedy, F.R.S., Mr. F. W. Lanchester, Professor A. P. Laurie, M.A., D.Sc., Professor Vivian Lewes, M.A., Mr. Michael Longridge, Mr. W. H. Maw, M.I.C.E., Sir Hiram Maxim, Captain Moore, R.N., Sir Henry Norman, M.P., Mr. F. G. Ogilvie, C.B., Major-General G. K. Scott Moncrief, Mr. Wilfrid Stokes, Mr. James Swinburne, F.R.S., Sir Joseph John Thomson, F.R.S., Mr. A. J. Walter, K.C., Mr. C. J. Wilson.

All communications should be addressed to the Comptroller at the address mentioned.



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Are made in a large number of sizes from 10 in. diameter upwards.

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Some Points worth noting.

Owing to few wearing parts, the Fans are not liable to break down. The mechanical efficiency is high and remains so. The pressure is steady and the volume even and free from pulsations.

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BELFAST.

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AS SUPPLIED TO THE
BRITISH
ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.
We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Celtic Collieries, Ltd., Cardiff.

Telegraph: "OUTPUT, CARDIFF." **Telephone: 4640 & 4641.**

New Companies.

Components Munitions, Limited.—Capital £10,000 in £1 shares.

Trafford Engineering Company, Limited.—Capital £30,000 in £1 shares. Registered office: 34, Waterloo Street, Birmingham.

Stratford Engineering and Grinding Mills, Limited.—Capital £10,000 in £1 shares, to carry on the business of mechanical, electrical and general engineers, etc.

Snyder Electric Furnace Company, Limited.—Capital £1,000 in £1 shares. The first directors are: G. J. Stock, C. J. H. Stock, G. H. Watson and F. T. Snyder.

Walsall Munitions, Limited.—Capital £4,000 in £1 shares. The first directors are W. M. Brooks, W. J. Talbot and S. L. Thacker. Registered office: Kingswood, Bridge Street, Walsall.

London Ordnance Works, Limited.—Capital £100,000 in £1 shares. Objects: To carry on the business of manufacturers of and dealers in guns, rifles, shells, projectiles, armour-plates, etc.

W. & J. Lawley.—Capital of £20,000 in £1 shares, to carry on the business of engineers, iron and brass founders, enamellers, etc. Registered office: Britannia Foundry, Sam's Lane, West Bromwich.

Bruce Lindsay Bros., Limited.—Capital of £30,000 in £1 shares (9,000 preference and 21,000 ordinary), to carry on the business of coal and iron merchants, coal exporters, colliery proprietors, ironmasters, etc.

David King & Sons, Limited.—Capital £55,000 in £1 shares, to acquire as a going concern the business of David King & Sons, ironfounders, Possilpark, Glasgow. Registered office: Keppoch Iron Works, Possilpark, Glasgow.

New Whitemetal Company, Limited.—Capital £1,000 in £1 shares, to take over the invention for an improved alloy, to adopt an agreement with Mr. C. R. Denton, and to take over the business of steel, iron and metal manufacturers.

Colby Brothers, Limited.—Capital £10,000 in £1 shares (5,000 6 per cent. cumulative preference), to carry on the business of shipbuilders, constructors, and repairers, of steam engines, etc. Registered office. Carlton Colville, Suffolk.

Swain, Verney & Company.—Capital of £3,000 in £1 shares, to take over the business formerly carried on by A. Swain and J. J. Silk, at 22, Granville Street, Birmingham, and to carry on the business of founders, metal workers, etc. Registered office, 22, Granville Street, Birmingham.

Lune Valley Engineering Company, Limited.—Capital £10,000 in £1 shares, to take over the business carried on at Lancaster as the Lune Valley Engineering Company. The first directors are Mr. G. M. Petty, Mr. A. E. Taite, Mr. J. A. Cross, Mr. J. G. A. Kitchen, and Mr. L. P. Perkins.

Wm. Heap & Partners, Limited.—Capital of £10,000 in £1 shares (8,000 preferred), to take over the business of engineers, manufacturers' agents, and merchants carried on by J. D. Crichton and A. H. Atkins as William Heap & Company. Registered office: Royal Liver Building, Water Street, Liverpool.

Marshall, Fleming & Company, Limited.—Capital £50,000 in 15,000 6 per cent. cumulative preference and 35,000 ordinary shares of £1 each, to take over the business of crane builders and engineers carried on by J. Marshall, J. Fleming, and R. S. Anderson at Motherwell as Marshall, Fleming & Company. The first directors are J. Marshall, J. Fleming, R. S. Anderson, and A. L. Wright.

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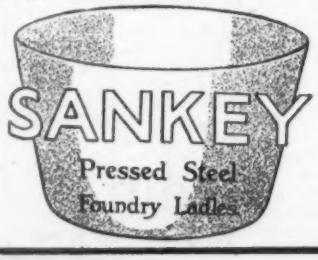

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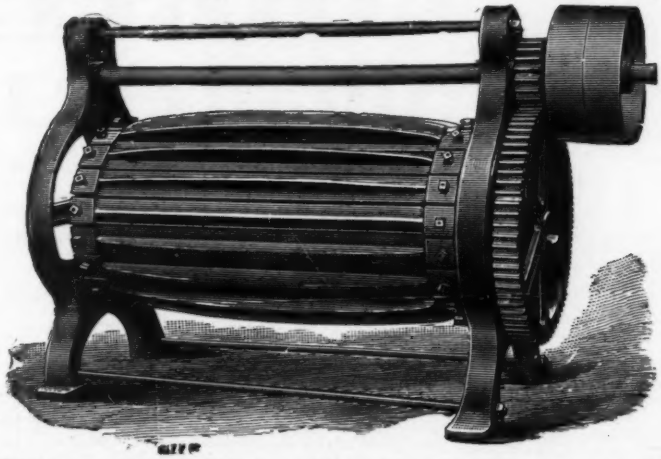

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Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-iron.

Cleveland.

	s.	d.
Cleveland No. 1	71	0
,, No. 3	65	6
,, No. 4 foundry	65	0
,, No. 4 forge	64	6
,, Mottled	64	6
,, White	64	0
East Coast hematite, mixed Nos. ..	96	6
Cleveland warrants	64	11

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s.	d.
Standard Foundry (Glasgow Market settlement price)	64	6
Warrants, ditto	70	10½

Makers' prices:—	s.	d.		s.	d.
Gartsherrie No. 1..	85	0	No. 3..	80	0
Coltness No. 1..	102	0	No 3..	82	0
Summerlee No. 1..	86	0	No. 3..	81	0
Langloan No. 1..	85	0	No. 3..	80	0
Calder No. 1..	80	0	No. 3..	75	0
Clyde No. 1..	86	0	No. 3..	81	0
Carnbroe No. 1..	83	0	No. 3..	79	0
Monkland No. 1..	81	0	No. 3..	79	6
Shotts No. 1..	82	6	No. 3..	81	0
Govan No. 1..	75	6	No. 3..	74	6

(All deliverable alongside Glasgow.)

Glengarnock	No. 1 .	86	0	No. 3..	81 0

(Deliverable alongside Ardrossan.)

Dalmellington	No. 1	82	0	No. 3..	80 0
Eglinton	No. 1..	79	0	No. 3..	78 0

(Deliverable alongside Ayr.)

Carron	No. 1..	86	0	No. 3..	81 0

(F.a.s. Grangemouth.)

Lancashire.

	s.	d.	s.	d.
Lancashire No 3 foundry f.o.t.	—		—	
Lincolnshire No. 3 foundry ..	—		76	9
Derbyshire No. 3 foundry ..	72	0	73	6
Staffordshire No. 3 foundry ..	—		71	6
Cleveland No. 3 foundry ..	74	6	75	0

(All delivered equal Manchester.)

Scotch No. 3	Gartsherrie	—	86 0
	Glengarnock	—	85 0
	Eglinton	—	Nom.
	Summerlee	—	87 0

(Delivered Manchester Docks.)

North-West of England.

	s.	d.	s.	d.
Bessemer mixed numbers net f.o.b.	106	0	107	0
Hematite warrant net cash ..	—		95	0
Lorn cold-blast charcoal iron ..	—		—	

The Midlands.

		s.	d.	s.	d.
Staffs.	Common forge ..	65	0	66	0
	Part Mine forge ..	67	6	68	6
	Best All Mine ..	97	6	100	0
	Cold Blast	—		155	0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry ..	—	—
Leicestershire foundry	—	—
Shropshire Cold-Blast	—	—

Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s.	d.	s.	d.
Forge	—		—	
Grey forge..	—		—	
Basic	—		—	
No. 3 foundry	—		—	
No. 4 foundry	—		—	

F.o.t. Makers' works.

South Wales.

	s.	d.	s.	d.
Welsh Hematite	102	6	105	0

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£	s.	d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	28	0	0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	26	10	0
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	25	0	0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	80	0	0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy ..	0	9	0
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	15	15	0
Ferro-titanium: 15/18%, per pound, flat	0	0	6½
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0	18	0
Ferro-phosphorus: 20/25%. Per ton	16	10	0
*Ferro-manganese 80%	20	0	0
,, export		—	

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£	s.	d.		£	s.	d.
Columns (plain)	7	7	6	to	7	12	6
Pipes, 1½ to 2½ in. ..	7	5	0		7	15	0
,, 3 to 4 in. ..	6	12	6		6	17	6
,, 5 to 8 in. ..	6	7	6		6	10	0
,, 10 to 16 in. ..	6	7	6		—		
,, 18 to 24 in. ..	6	7	6		—		
Chairs	4	7	6		4	10	0
Floor plates (open sand) (At work).	3	10	0		3	12	6

Non-Ferrous Metals.

	Copper.	£	s.	d.	£	s.	d.
Standard, Cash ..		67	12	6	67	17	6
Three months ..		68	17	6	69	2	6
Electrolytic		84	0	0	85	0	0
Tough		76	10	0	77	10	0
Best selected		76	10	0	77	10	0
	Tin.						
Standard, Cash ..		154	10	0	155	0	0
,, Three months		155	5	0	155	15	0
English Ingots ..			—		155	0	0
Bars			—		156	0	0
Refined		159	0	0	160	0	0
	Spelter.						
American		..	..	—	77	0	0
Specials		..	..	—		—	
Hard		45	0	0	50	0	0
British		75	0	0	78	0	0
	Lead.						
Soft foreign ..		..	..	—	23	2	6
English		23	10	0	23	15	0
	Antimony.						
Regulus		..	..	—	100	0	0
	Aluminium.						
Virgin Metal, 98/99%	..per ton				185	0	0
	***Chromium (Metallic).**						
98/99% purity	per lb. ..				—		
	***Nickel.**						
In cubes, 98/99% purity	Per ton				220	0	0
	***Tungsten Metal Powder.**						
96/98% purity ..	per lb. ..				0	8	6
	***Molybdenum Metal.**						
96/98% purity..	per lb. ..				—		
	***Cobalt Metal.**						
97% purity ..	per lb. ..				0	8	0
	Quicksilver.						
75 lb. bottle					16	12	6

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.		s.	d.
Steel scrap, heavy melting ..	67	6	to	70	0
Iron scrap cast (cupola metal)	55	0		56	0

London (f.o.b.).

Heavy steel	60	0			
Light ,, ...	50	0			
Heavy cast	60	0			

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations: —

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap ..	80	0	0
Hy. Selected Scrap Brass	64	0	0
Hy. Tinned Copper Wire ..	68	0	0
Best Selected Gunmetal Scrap .	73	0	0

Re-melted Ingot Lead 30s. under English Lead price on date of order.

Stocks.

Pig-Iron in Public Store.

	Sept. 2. Tons.	Inc. + or Dec. — since Sept. 3, 1914. Tons.
Connal's at Glasgow Scotch	1,000	No change
Ditto other makes ..	—	— 2
Connal's at Middlesbrough	142,069	+ 49,060
Connal's at Middlesbrough hematite ..	—	No change.
West Coast hematite..	2,388	— 697

Metals.

Copper, Europe and afloat	39,237	+ 4,431
Tin, London, Holland, U.S.A. and afloat ..	17,376	+ 953

Coke.

Middlesbrough.

	s.	d.		s.	d.
Gas Coke	—			28	0
Foundry Coke	32	6	to	35	0
Furnace coke	—			25	3

Newcastle-on-Tyne.

FOUNDRY COKE—	s.	d.	F.o.b. Dunston. s.	d.
Original Garesfield ..	—		32	6
Mickley	—		32	6
Stella Garesfield ..	—		32	6
Priestman's Garesfield	—		32	6
Consett Garesfield ..	—		32	6
Newcastle gas coke ..	—		29	6

Cardiff.

	s.	d.		s.	d.
Special foundry coke ..	40	0	to	42	6
Foundry coke	36	0	to	40	0
Furnace coke	30	0	to	33	0

Leeds.

Furnace coke (washed) ..	—		16	0

Birmingham.

Foundry coke	—	—
Furnace ,, ...	—	—
Gas ,, ...	—	—

Glasgow.

Foundry coke	—	—
Furnace ,, ...	—	—
Gas ,, ...	—	—

London.

Welsh or Durham Foundry, d/d London Stations, in truck	—		46	0
Yorkshire, d/d London Stations, in truck ..	—		32	6

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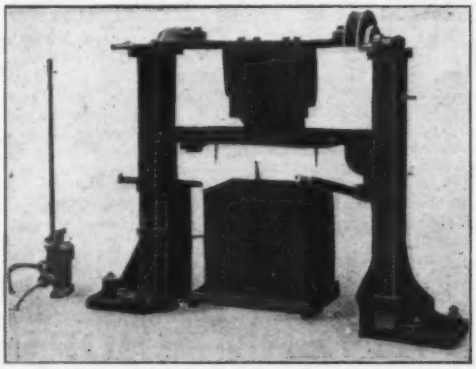

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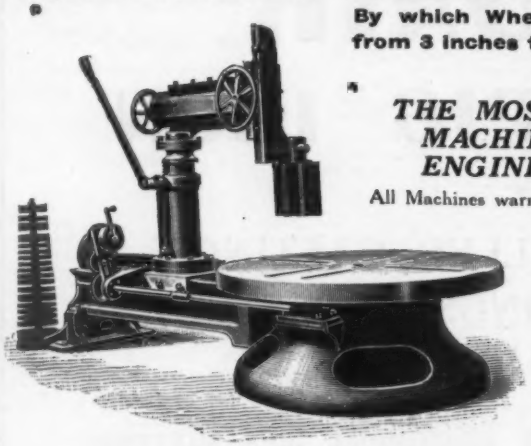

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